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A METHODOLOGY FOR ANALYZING

ARMS CONTROL PROPOSALS

THESIS

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Captain, USAF

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A METHODOLOGY FOR ANALYZING ARMS CONTROL PROPOSALS

THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Operations Research

William E. Hanson

Captain, USAF

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PREFACE

This thesis was a two-edged effort. My major thrust was to develop a method to use dynamic measures of nuclear strength to gain insight into the arms control process. My second desire was to show that they recently developed BRIK nuclear exchange model could be used as a tool to perform such an analysis. I hope that future students and analysts will be able to use this model and method to help chart our nation's path in an uncertain future of nuclear arms reduction.

I wish to thank my triumvirate of advisors, Lt Col Ivy D. Cook, Maj James K. Feldman, and Maj William A. Rowell for their guidance and insight. Major Feldman gave the initial impetus towards working with the arms control problem. Lt Col Cook provided valuable insight into the inner workings of BRIK, and Maj Rowell added his expertise in nuclear exchange modeling and nuclear force structures.

I also wish to thank my family for their understanding and support. Without Carolyn and Joshua's patience and -- especially -- my wife Mary's encouragement and love, this work would not have meant as much.

William E. Hanson

Contents

List of Figures

List of Tables

ABSTRACT

The purpose of this thesis is to develop a method for analyzing nuclear arms control proposals. It follows a modified systems analysis paradigm, centering about the use of the BRIK goal-programming nuclear exchange model.

The objectives of deterrence and arms control are discussed, and it is shown that major goals are increasing stability and maximizing second-strike capability. Measures of effectiveness for these goals were developed.

Two arms control proposals, one based on the Reagan administration's START plan, and the other proposed by retired Air Force General Glenn Kent were evaluated over a ten-year period using the BRIK model. Forces were built and measures of merit generated for each proposal using three targeting strategies.

The procedure for using the BRIK model followed a three-step process. First, new weapons systems were added to the weapons base. Next, the BRIK model was used to achieve specified damage expectancy goals on the Soviet target base. Finally, a Soviet first strike was made against the U.S. forces. These three steps generated all data required to calculate the various measures of merit.

To complete the analysis, the two alternatives were rated under the measures of merit. It was determined that, given the data and assumptions of this study, a decision maker should narrowly favor the START proposal.

CHAPTER ONE: INTRODUCTION

THE IMPORTANCE OF ARMS CONTROL

Since the 1950's, a delicate "balance of terror" has reigned. Both the United States and the Soviet Union have had the ability to destroy the other's society, but not the ability to destroy the other side's retaliatory capability. Many experts feel that this balance is shifting. The advent of new, highly accurate weapons has begun to make it conceivable that one side could effectively disarm the other in a pre-emptive first strike. If this becomes possible, one side might try for a "final solution."

Ironically, this shift in the nuclear balance has come about despite the vast increases in both numbers and destructive power of both the U.S. and Soviet nuclear arsenals. It has been argued that this growth in strategic forces has in fact caused each side to become more vulnerable to a first strike attack by the other. (15:1) This state of affairs has been labeled the "window of vulnerability". (8:I-8) If this is true, the U.S. defense build-up has, in fact, eroded our national security rather than strengthened it.

This build-up of destructive power and reduction of stability has occurred despite previous arms limitation talks. The number of nuclear warheads has increased since 1970 from about 1500 on each side to approximately 8000. Even more ominous is the fact that the number of warheads could almost

redouble to around 15000 and still remain within the SALT II limits. Also, Soviet missile throw-weight has increased by nearly 2 million kilograms since the signing of SALT I. (15:1)

This state of affairs has sparked an outcry, particularly from members of Congress, for genuine reduction in the destructive capability of each side's nuclear arsenal. In particular, the capability for each side to destroy the other's forces must be curbed. (15:1)

Even if one does not believe in the "window of vulnerability", the idea of limiting the great number of nuclear warheads is very attractive. However, proponents of different arms control schemes are divided on how to reduce the number of nuclear weapons. Important arms control issues are:

1) How much (or little) is enough?
2) Do we keep building new systems?
3) What is the objective of arms control?
4) What do we count?

PURPOSE OF THIS THESIS

A methodology must be developed to answer these questions. L.D. Attaway's systems analysis paradigm, as modified by J. K. Feldman, gives a basic framework which will be useful in adressing these important arms control questions.

1) Determine the objectives. What does the United States desire to achieve?

2) Determine measures of effectiveness. How well is the U.S. achieving its objectives?

3) Determine the alternatives. How can the U.S. achieve its objectives?

4) Evaluate the alternatives. That is, use a model or other means to determine how well each alternative achieves the U.S. objectives.

5) Rank the alternatives in accordance with the measures of effectiveness. (19:55)(9)

Using this framework, this thesis proposes a methodology to help an analyst generate and analyze arms control agreements. All of the elements of systems analysis will be used, but particular effort will be spent on the evaluation of alternatives. The BRIK goal-programming nuclear exchange model was the principal tool used in making these evaluations. (2) The BRIK model was developed as a thesis project by Bunnell and Takacs in 1984. Its quick run-times, and goal-programming capabilities showed particular promise in the analysis of arms control agreements. (2:104) This thesis demonstrates how a DoD analyst, using authoritative U.S. nuclear objectives and capabilities, can both generate and evaluate future U.S. nuclear force structures under alternative arms reduction schemes.

The secondary purpose of this thesis is to continue the development of BRIK as a valuable analytic tool. New features have been added to BRIK, and some deficiencies of the model have been corrected.

GENERAL APPROACH

In keeping with the framework, the objectives of arms control will be developed. These objectives encompass both arms control and national security considerations. Next, appropriate measures of effectiveness associated with each set of objectives are treated. These measures will cover areas of force capability, stability, and survivability.

Given proposed arms control limits, and specific U.S. targeting strategies, the BRIK nuclear exchange model is used to design an "optimal" U.S. force structure. Subsequently, BRIK is used to evaluate the capability of this chosen force structure under different force posture assumptions. This general procedure is performed for a combination of two different arms control limits and three nuclear targeting strategies. Finally, these results are assessed and the implications for future U.S. forces given.

OVERVIEW OF FUTURE CHAPTERS

Chapter Two presents the background of the analysis. The purposes of arms control and some measures of merit are discussed. Two potential arms reduction agreements are presented and their pros and cons explored. The concept of

deterrence and its implementation in various targeting strategies along with its measures of merit are explained.

Chapter Three discusses the methodology and assumptions of the analysis. In particular, the scenario, weapon and target characteristics, and time horizons of the study are elaborated on. Additionally, it is shown how BRIK helps determine U.S. and Soviet forces, capabilities, and measures of merit.

Chapter Four gives an overview of BRIK, including its strengths and weaknesses. Important new changes and corrections to the model are also covered.

Chapter Five discusses the results of the analysis as well as the potential implications of these results to the present arms control situation.

Chapter Six summarizes the analysis. The methodology, evolution of forces and capabilities, and implications are restated. Finally, future directions for study and improvement are suggested.

This completes the introduction to the thesis. The next chapter will develop the problem objectives, alternatives, and measures of merit.

CHAPTER TWO: ARMS CONTROL AND DETERRENCE

OVERVIEW

This chapter develops the concepts of arms control and deterrence, and discusses several ways that each can be implemented. First, the purposes of arms control will be developed emphasizing the role of arms control in decreasing the chance of nuclear war by increasing stability. Next, two possible strategies for arms control, the Reagan Administration's Strategic Arms Reduction Talks (START) proposal and retired Air Force General Glenn Kent's proposal for decreases in the number of Standard Weapons Stations, will be introduced. The proposed mechanisms for arms reduction and some of the pros and cons of the two plans will be examined. The concept of deterrence and its basis in national security interests will be explored and three different strategic nuclear targeting strategies for implementing deterrence will be developed.

PURPOSES OF ARMS CONTROL

If arms control is to be meaningful, it must accomplish three goals:

1) Reduce the chance of nuclear war.
2) Reduce the level of damage if nuclear war occurs.
3) Reduce the cost of nuclear forces.

Reducing the chance of war

In the lexicon of arms controllers, the key word in reducing the chances of conflict is stability. Stability can be defined in several different ways. The first of these is strategic stability.

The notion of strategic stability rests on the assurance that neither side can seriously damage the other's retaliatory capability. (27:7) This idea has long been with us. From the earliest beginnings of the "massive retaliation" doctrine of the 1950's through flexible response and the countervailing strategy of the 1970's, the cornerstone of our deterrence has always been the assurance that no matter what the Soviets did, we would always have enough capability to inflict uncacceptable damage in a second strike.

One key facet of our ability to maintain this stability is the triad of nuclear forces. While some may doubt the efficacy of splitting our nuclear eggs into several baskets, the triad of land-based ICBM's, SLBM's and bombers contributes in two major ways to our nuclear deterrent.

First, it would be difficult for an enemy to destroy all three legs of the triad. The SLBMs at sea are relatively invulnerable. Likewise, ICBMs and bombers effectively protect each other. That is, a simultaneous attack on bombers and ICBM's by Soviet ICBM's or SLBM's would provide plenty of warning for the bombers to launch. (20:7-8) In fact, bombers can be launched even before an enemy attack to

ensure their survival. Also, bombers could be launched as a show of national resolve in a crisis, and recalled if necessary. (12:4429) Likewise, an attack on bomber bases using SLBM's would give the ICBM's additional time to launch. Under almost any conceivable first-strike attack, two out of the three legs of the triad would be expected to survive intact.

The second reason for the triad is the offensive synergism among the three legs. The requirement for the Soviets to defend against three very different forces keeps them from concentrating their efforts on any single force. For example, the Soviet air defense network would probably be very badly degraded by a prompt U.S. ICBM and SLBM response to a Soviet first strike. This type of interplay between the legs of the triad also helps to insure that our deterrent capability will not be completely nullified or seriously degraded. (12:4151)

Furthermore, each leg of the triad has unique properties. For example, SLBMs can stay hidden for long periods of time giving them an excellent capability in a reserve role. Bombers can be launched without committing them to attack. ICBMs have the advantages of high alert rates, command and control, and rapid retargeting. (20:8) Taken together, these qualities provide tremendous flexibility for responding to an attack.

Proposals have been made to modify this concept. For example, in the Senate testimony on MX (Peacekeeper) missile basing modes, the use of submarine basing for the Peacekeeper was discussed. While this mode is certainly survivable, the land-based ICBM advantages of high alert rates and excellent command and control would be lost. Likewise, any advances in Soviet antisubmarine warfare would put both the SLBM and Peacekeeper forces in jeopardy. (11:300) While other dyads of forces have been proposed, it is not likely that the U.S. will abandon the triad in the near future. (13:294)

Another facet of stability is crisis stability. This occurs when neither side has any reason to launch or expect a pre-emptive attack. (27:7) If one side thought it could destroy the other side's deterrent, then it might feel that it could get away with such an attack. On the other hand, the side which felt that it would lose its deterrent capability could feel compelled to use its forces first in a crisis situation rather than risk losing them. (15:3) Thus both sides would be on a "hair trigger" -- ready to go at the slightest provocation.

..ere are many factors affecting crisis stability, such as alert posture and the vulnerability of the C^3I network, the driving factor is the introduction of new, highly accurate missiles, especially MIRVed missiles. The accuracy of these missiles gives them a high probability of

kill against the enemy's missiles, and the large number of warheads carried on each missile make them tempting targets in their own right. That is, it makes "sense" to use two warheads if they can destroy a single missile which carries eight or ten warheads. (25:39) Because U.S. land-based missiles constitute only about 30% of the total number of nuclear warheads, Soviet planners must also find a way to defeat the rest of the triad. However, the Soviets could see a U.S. ICBM first-strike capability as a very real threat to their deterrent, since about 70% of their warheads are on MIRVed land-based missiles. (22:2)

A third type of stability is arms race stability. In this situation neither side feels that it must embark on new armament programs to keep its strategic and crisis stability intact. (27:7) New weapons would therefore help to improve each side's second strike capability, rather than improving a first strike capability, which would harm crisis stability. While we cannot turn the clock back to make our missiles less accurate, we can deploy them in ways that make them more survivable, so as not to put us in a "use or lose" situation. For example, mobile ICBMs with only one warhead would be a very survivable system, because they are unattractive to target because of large weapons requirements, and would not be seen as a first strike weapon.

Increasing stability in all three areas -- strategic, crisis, and arms race -- does one important thing -- it

reduces the danger that one side will initiate a nuclear strike. If neither side can possibly gain by striking first, then nuclear war is less likely to begin.

How can stability be measured? Strategic stability can be measured in terms of second strike capability. If the retaliatory strike of either side can inflict unacceptable damage on the other, then strategic stability will be assured. Three measures used in this study are U.S. second strike damage expectancy (DE) against the Soviet target base, U.S. residual weapons available, and Soviet second strike equivalent megatonnage (EMT).

On the other hand, crisis stability is a first strike concern. The issues are whether or not a side can gain by launching a first strike and how survivable its forces are. Measures of effectiveness used are variations of number of first strike warheads used versus number of warheads destroyed.

Damage limitation

The second goal of arms control is damage limitation. It has been pointed out by some theorists that the combined nuclear arsenals of the USSR and U.S. far exceed the number required to destroy life on earth as we know it. To believers in "nuclear winter", even a relatively small number of weapons could create a vast climate change which would send the world into an Ice Age in a relatively short time. (26:33) Even if climatic catastrophe is discounted, arms

limitation agreements offer no real hope in the forseeable future for significantly reducing the effects of nuclear weapons used against population targets. (15:1)

Cost Reduction

Cost is an important consideration. Some type of cost/benefit criterion could be used to fully evaluate arms control agreements. For example, it is likely that an agreement which forced early retirement of systems would result in savings in operational and support costs. The Congressional Budget Office (CBO) estimates that $1.8 billion could be saved annually under the administration START proposal. (3:23) However, a complete cost analysis of future force structures under arms control is beyond the scope of this effort.

Objective of Arms Control

For the purposes of this study, the objectives of arms control lie primarily in the area of increasing crisis, strategic, and arms race stability.

PROPOSED ARMS CONTROL AGREEMENTS

While there are many arms control proposals, this study will concern itself with two major ones, which both show promise. As stated earlier, this thesis is not meant to be a study of the relative merits of actual arms control proposals and force structures. Rather, it is meant to show how the BRIK model can be used to evaluate and compare different arms control proposals.

The first proposal is similar to the Reagan Administration's START proposal, while the second is a proposal put forward by retired General Glenn A. Kent, now with RAND.

Administration START Proposal

The administration's proposal is primarily concerned with ballistic missile warheads. It proposes to limit the total number of both ICBM and SLBM warheads to 5000. (3:22) This approach recognizes that the growth in the number of highly-accurate fixed land-based missiles greatly reduces the stability of the nuclear balance. (3:19)

According to a CBO study, the centerpiece of the START proposal is a "build-down" where two ballistic missile warheads are destroyed for every new MIRVed ICBM warhead deployed, and three ballistic missile warheads are destroyed for every two new MIRVed SLBM warheads deployed. Single warhead missiles would be traded on a one for one basis. Additionally, each side would have to reduce the number of ballistic missile warheads by a minimum of five percent each year. This would prohibit either side from avoiding arms reduction by ceasing modernization. (3:22)

Additionally, there would be a ceiling of 3500 ALCMs. (3:22)

Over a ten-year period, this would reduce the number of missile warheads on each side by approximately 40 percent. The 3500 ALCM ceiling would not limit the ongoing U.S.

conversion of B-52 bombers to ALCM carriers, nor would it hamper the Soviets in their bomber modernization program. While the Soviets say that the ALCM limit would maintain the large U.S. advantage in air-breathing nuclear capability, it can be argued that these weapons are retaliatory in nature and do not threaten either strategic or crisis stability. (22:2-3) Others have pointed out that this type of scheme calls for asymmetr.. reductions since both sides have different number of missile warheads. (15:10) However, imbalances in the key measures of number of warheads and throw-weight would become smaller over time. This is because a START agreement would cause large cuts in the Soviet land-based ICBM force, which accounts for most of the Soviet throw-weight advantage. The U.S. reductions, while a smaller percentage of U.S. throw-weight, would cut down the U.S. advantage in total bomber and missile warheads. (3:31)

The primary purpose of the two-for-one build down is "to discourage the deployment of powerful but increasingly vulnerable systems -- like MIRVed ICBMs deployed in fixed locations -- in favor of more survivable ones." (3:5) The reason for this is that building MIRVed ICBMs requires two warheads to be destroyed for every new MIRV warhead, but only a one for one trade if single-warhead ICBMs are built. Ten warheads on a single missile also makes it a tempting target because only two are needed to destroy it. (3:19-21) However, the same ten warheads on ten different missiles

would require twenty warheads to destroy them. If the missiles are mobile, they will be even more difficult to destroy. The two for one versus one for one build down encourages the deployment of more survivable and stable systems.

Modification of START

For the purpose of this study, the "floor" of 5000 ballistic missile warheads was removed. This was done because five percent annual reductions for ten years resulted in a limit of only 4479 warheads. It was decided to continue the proposal for the full ten years to match General Kent's proposal.

General Kent's Proposal

General Kent has proposed a new common coin for nuclear forces, the "Standard Weapon Station" (SWS). The SWS is similar to a single ballistic missile RV, a bomb on a bomber, or a cruise missile. (15:15) However, the rules for calculating SWS are based on throw-weight. (15:25) Since stability or lack thereof is based on one side's ability to attack the other in a counterforce strike, Kent argues that throw-weight is an important surrogate measure for counterforce capability. (15:34-40) This is because increased missile throw-weight can translate into larger, heavier, and more accurate RV's. For MIRVed missiles, this throw-weight is divided into 400 kilogram units and into 500 kilogram units for single ICBMs. (15:25) Thus, a Peacekeeper missile

with a throw-weight of about 4000 kilograms would count for 10 SWS, while a Soviet SS-18, with it's much greater throw-weight of around 8000 kilograms would account for 20 SWS.

The concept is simple enough for missiles, but how do we take bombers into account? General Kent proposes the use of takeoff gross weight as a surrogate measure for bomber throw-weight. Of course, since bombers are much larger than missiles in relation to the weapon load, the divisor is much higher. The proposed measure is one SWS for every 50,000 pounds of takeoff gross weight for non-ALCM carrying bombers, and one SWS per 25,000 pounds for ALCM carrying aircraft. (15:43-44) For B-52 aircraft, this would translate into 10 SWS per non-ALCM carrier and 20 SWS per ALCM carrier, which agree fairly well with current and planned U.S. weapon-carrying capabilities. (24:273)

Once one gets beyond the calculus of the SWS, the arms reduction idea is fairly simple. Kent proposes a straight-line reduction of five percent per year in the number of SWS. (15:15) This appears to give an attractive proposal for the following reasons:

1) By putting everything into a common currency, each side will be able to structure its forces as it wishes.

2) According to Kent's figures, both sides are nearly equal in terms of SWS. Thus, the U.S. advantage in air-breathing forces is balanced against the Soviet lead in land-based ICBMs and throw-weight.

3) By penalizing large, heavy ICBMs, this proposal encourages both sides to reduce their numbers thus increasing stability. At the same time, the SWS calculation encourages each side to increase the survivability of its own force by such means as the deployment of small, single-warhead mobile ICBMs. (15:24-25)

DETERRENCE AND TARGETING STRATEGIES

What Constitutes Deterrence

At the bedrock of deterrence is the fact that nuclear weapons have greatly raised the stakes in the game of world politics. Now, as never before, national (not to mention global) extinction is a very real possibility. Neither side will agree to anything that could threaten their survival as a nation or other important national interests. As much as we and the Soviets would like to control nuclear weaponry, there cannot be agreement if either side feels that its national survival is in any way threatened.

The basic idea of deterrence is rather simple. Benjamin Franklin's oft-quoted homily that "one sword keeps another in its scabbard" gives the basic idea. In other words, the consequences of an action outweigh the gains. However, there are some rather important caveats to this idea.

The most important thing to remember is that deterrence is in the eye of the beholder. That is, what your enemy

thinks you can and will do is more important than what you think you can and will do. If the Soviet Union does not feel that the U.S. will react to agression, then our capability to react will not necessarily deter them from taking actions they believe are in their interest.

Another facet of deterrence is that the enemy's perception of what is or is not harmful affects our ability to deter him. If what we consider as an unacceptable consequence to the Soviet Union is in fact acceptable to the Soviet Union, a strategy or force aimed at inflicting that "unacceptable" consequence will not deter the Soviets.

Another implicit assumption of deterrence is that the enemy is rational and will only fight when gains outweigh the losses. (17:3) Unfortunately, this is often not the case. Even a cursory glance at history will show that wars have been fought by mistake, for religious reasons, to satisfy public opinion, to gain advantage in internal politics, and even for honor and sport. To most, these are not rational reasons for fighting. However, in order to analyze or predict Soviet behavior, we must assume some rationality on the part of our opponents, otherwise our best course might be to destroy them before they destroy us.

We will assume that deterrence has four basic elements: our knowledge of what the Soviets value, our capability to

inflict damage on the things they value, the will to use that capability, and Soviet perception of the first three elements.

Will and perception are intangible, and although important, are not readily amenable to quantification or measurement. So we will concentrate on the first two elements: what do the Soviets value and what are the U.S. capabilities against those targets.

<u>What Do the Soviets Value?</u>

It is not clear exactly what the Soviets do value. While it is dangerous to believe that the Soviets value the same things we do, certain things appear to be important to them. In no particular order, these are:

1) Leadership and Command and Control Facilities. If the Soviet leaders are convinced that, if they start a war, they will lose control of their society, they will think long and hard before embarking on such a course. Likewise, if the centers and tools of control are destroyed, neither they nor their successors will be able to continue ruling.

2) Nuclear Forces. The Soviet nuclear arsenal has more than any other element propelled the USSR into "superpower" status. Destruction of Soviet Strategic Rocket Forces, SLBM's, Long Range Aviation, IRBM's, nuclear storage, and the ability to command and control these weapons would

certainly be a serious setback. Additionally, the loss of these weapons would keep the Soviets from dominating the post-nuclear-exchange world.

3) Conventional and Theater Forces. As with nuclear forces, these are key elements of Soviet status. They provide another means of control of the population, especially in the case of the large numbers of minorities, not to mention the states of the Warsaw Pact.

4) Economic and Industrial Facilities. If we can take away the Soviet Union's ability to function as a modern industrial nation, we have certainly dealt it a crushing blow. Factories, power plants, fuel refineries and storage, rail and road nets, and other key facilities could be included in this classification. Note also that, since most factories and other industrial facilities are located in or near major population centers, an attack on economic and industrial targets would also destroy major population centers. (6:41-42)

Taken in appropriate combinations, these four classes of targets could be used to create targeting strategies which would implement alternative concepts of deterrence. For example, one who felt, as McNamara did in the 60's, that the ability to deter rested on the ability to destroy two-thirds of the Soviet industrial base, would build a force to attack the economic and industrial target class. (16:82) Alternatively, one could take the CBO idea of

finite deterrence, and destroy a fixed percentage of urban industrial and military targets. (23:5) Advocates of counterforce strategy would emphasize the attack of nuclear forces. This list could continue for all appropriate combinations of targets which would support alternative concepts of deterrence.

Implementation of Deterrence

This study will use three different targeting strategies. These strategies provide a good cross-section of the alternative major emphases in strategic nuclear targeting. Each strategy is a set of the four key Soviet target elements mentioned earlier, but arranged in differing priority orders. For a breakdown of each targeting strategy, see Table 2.1.

One targeting plan that is not used is that of striking a relatively small number of Soviet population centers. This is because such a strategy would require a relatively small number of weapons whose force structure could easily be determined. Since the U.S. has continued to push for large numbers of highly accurate weapons, it is doubtful that a "city busting" strategy is being implemented.

This gives a broad brush treatment of the various philosophies in this area. While it is not suggested that any of these are the actual philosophy used to build the SIOP, most strategists will find one of these to their liking.

TABLE 2.1

TARGETING PRIORITIES AND DAMAGE EXPECTANCY (DE) GOALS

TARGET STRATEGY	TARGET CLASSES	DE GOAL (GENERATED)	DE GOAL (DAY-TO-DAY)
LEADERSHIP	LEADERSHIP, C^3I	.8	.7
	NUCLEAR FORCES	.7	.6
	CONVENTIONAL FORCES	.6	.5
	ECONOMIC/INDUSTRIAL	.5	.4
COUNTERFORCE	NUCLEAR FORCES, C^3I	.8	.7
	CONVENTIONAL FORCES	.7	.6
	LEADERSHIP	.6	.5
	ECONOMIC/INDUSTRIAL	.5	.4
COUNTERVALUE	ECONOMIC/INDUSTRIAL	.8	.7
	LEADERSHIP, C^3I	.7	.6
	CONVENTIONAL FORCES	.6	.5
	NUCLEAR FORCES	.5	.4

Note that Table 2.1 also gives Damage Expectancy (DE) goals for each set of priorities using both generated and day-to-day alert postures. It has been stressed that two of the most important measures of force capability are DE accomplishment and residual weapons. General Davis, Commander in Chief, Strategic Air Command, has stated that DE (specifically military DE) "accurately depicts warfighting capability" and residual weapons "reflect war sustaining capability after counterforce or counterforce/countervalue exchanges." (12:4180) This thesis also uses these measures of merit. However, the residual weapon figure will reflect the number of ballistic missile warheads or SWS beyond those needed to meet DE goals that could be deployed under the

arms reduction plans rather than an actual reserve force. These residual weapons are not used in the allocation, nor are they targeted by the Soviets. They only represent a potential for improvement, and are not reserves in the usual sense.

SUMMARY

This chapter has covered the background of arms control and deterrence. The purposes of arms control have been developed, and it has been shown that the prevention of nuclear war through increased stability is the primary goal of arms control. Two different arms reduction proposals, one similar to the Reagan Administration's START proposal and one proposed by General Kent, were introduced, and their pros and cons were examined. Finally, the concerns of national security and deterrence were discussed, and three different nuclear targeting strategies were selected as possible ways to implement deterrence.

The next chapter will cover the assumptions and methodology used to evaluate the two arms control strategies.

CHAPTER 3: METHODOLOGY AND ASSUMPTIONS

OVERVIEW

This chapter will discuss the methodology and assumptions used in determining and analyzing future U.S. nuclear force structures under the two arms control strategies. Details of the nuclear exchange scenario used to determine and evaluate these force structures along with detailed weapon and target characteristics will be discussed. The methodology section will show how both U.S. and Soviet forces and capabilities are determined and will mention some important considerations for the analyst.

ASSUMPTIONS

Scenario

It is assumed that the Soviets begin the conflict with a counterforce first strike, aimed at U.S. ICBM silos, SAC bomber bases, submarine ports, and key leadership and C^3I targets. Because of possible fratricide problems, Soviet weapons are limited to a "2 on 1" attack on all targets. This strike would attempt to irrevocably shift the correlation of forces in favor of the Soviets by effectively disarming the U.S. The Soviets would hold the remaining weapons in reserve to deter the U.S. from responding.

However, the scenario does assume that the U.S. will retaliate to this agression. After this Soviet first strike, the U.S. would respond with an attack aimed at a

broad range of Soviet targets based on one of three selected targeting strategies. Any U.S. or Soviet weapons not used or destroyed would be available for additional strikes or bargaining purposes.

Some feel that the Soviets are unlikely to initiate such an exchange due to uncertainties such as the accuracy of North-South missile trajectories, fratricide and the U.S. will to retaliate. They point out that any first strike would be a tremendous gamble on the part of either nation. (24:264-265) Such a strike could could well put the aggressor "slightly behind the Fiji Islands." (21:14)

While such a course may seem unlikely, similar scenarios have been developed and analyzed during both the Carter and Reagan administrations. (5:56) (19:6) The use of other scenarios such as a U.S. first strike will give quite different results. However, only the Soviet first-strike scenario will be used in this analysis.

Soviet Weapon Base

Since the Soviets are not likely to tell us exactly what their nuclear forces structure will be, an analyst must rely on estimates of future Soviet capabilities and force structure. For a DoD analyst doing classified work, these estimates would probably come from various intelligence agencies and perhaps from civilian contractors or "think tanks".

This study uses the estimate of the Congressional Budget Office (CBO) for 1990 and 1995 Soviet forces which is

based on the administration's START proposal. (3:75) Adjusted very slightly, this same estimate is also appropriate for Kent's arms control proposal. Thus the evaluation of each arms control plan will assume the same Soviet strategic nuclear forces. See Table 3.1 for a year-by-year breakdown of the Soviet force structure.

TABLE 3.1

ESTIMATED SOVIET FORCE STRUCTURE

SYSTEM	WARHEADS	SWS	1985	1990	1995
SS-11	3	3.0	370	0	0
SS-13	1	1.0	60	0	0
SS-17	4	6.7	150	100	0
SS-18	8	20.0	308	150	45
SS-19	6	9.0	360	100	30
SS-X-24	10	20.0	0	150	150
SS-X-25	1	1.0	0	150	500
YANKEE	1	1.4	368	0	0
DELTA I,II	1	1.4	308	56	0
DELTA III	4	7.0	224	240	112
TYPHOON	9	9.0	40	160	200
BEAR	4	8.3	100	0	0
BISON	4	7.0	50	0	0
BACKFIRE LRA	4	5.5	100	125	125
BLACKJACK	12	20.0	0	50	125
BEAR H (CMC)	12	16.6	0	50	50

The figures for 1985 SS-11s and Delta IIIs were adjusted to agree with current estimates (14:164-65)
The 1990 and 1995 figures given by the CBO were a bit under the treaty requirements. It does not seem likely that the Soviets would get rid of weapons before they had to. Also, the CBO showed the Soviets keeping SS-11s and getting rid of SS-17s and SS-19s, which did not seem too effective, so these figures were slightly adjusted upward in all cases except for the SS-11s.

The characteristics of the Soviet force were drawn from various unclassified sources. Where data was unavailable, such as for the SS-X-24 and SS-X-25 and most of the bombers, extrapolations based on previous systems and U.S. counterparts were made. See Table 3.2 for details.

Soviet Target Base

This analysis builds on the large, unclassified target base used by the BRIK authors to test their model against the Arsenal Exchange Model. This target base gives a good cross-section of various targets and hardnesses. (2:79) Factories, naval facilities, military depots, energy, oil refineries and storage (POL), mobile ICBM (MICBM) and nuclear storage classes were added by the author to give more balance to the target base. See Table 3.3 for the detailed target base.

U.S. Weapon Base

The data for the U.S. weapons were drawn from various unclassified sources. Weapon characteristics for systems not yet deployed were based on extrapolation from present day weapons data. See Table 3.4 for details on the weapons base.

TABLE 3.2

SOVIET WEAPONS AND CHARACTERISTICS

NAME	WHD/WPN	PA	CEP	YLD	DAYALRT	GENALRT
SS11	1	.70	.76	1.00	.85	.98
SS11N3	3	.75	.59	.20	.85	.98
SS13	1	.75	1.08	.75	.85	.98
SS17	4	.75	.24	.75	.85	.98
SS18	8	.75	.22	.90	.85	.98
SS19	6	.75	.16	.55	.85	.98
YANKEE	1	.70	.48	1.00	.50	.75
DELTA	1	.70	.59	.90	.50	.75
DELTA3	4	.70	.32	.30	.50	.75
TYFOON	9	.75	.27	.20	.50	.75
BEAR	4	.70	1.00	1.00	.10	.80
BISON	4	.70	1.00	1.00	.10	.80
BFIRE	4	.75	.80	1.00	.10	.80
SS24	10	.80	.10	.50	.85	.98
SS25	1	.80	.10	.35	.85	.98
BEARCM	4	.70	.50	.35	.10	.80
BLKJAK	12	.75	.20	1.00	.10	.80

Except as noted, the source for this table is (14:164-65)
Reliability figures are from (25:16-17)
Alert rates assumed to be equal to U.S. alert rates except for bombers, which are assumed to have a low alert rate.
The Delta III warheads/weapon figure reflects an average of the number of warheads per missile.
All bomber figures are notional.
SS-24 and SS-25 figures are notional. it is assumed that the SS-24 will be a counterpart to the U.S. MX, and the SS-25 to the U.S. Small ICBM.
LEGEND:

PA = Probability of Arrival
CEP = Circular Error Probable (NM)
YLD = Yield (MT)
DAYALRT = Day-to-day alert rate
GENALRT = Generated alert rate

TABLE 3.3

SOVIET TARGET BASE

NAME	NUMBER	VULNERABILITY	DIAMETER	TYPE	VALUE
CIVIL	140	24Q0	.56	M	1.00
LOCAL	215	13P1	.49	M	1.00
C3I	450	35P7	.00	M	1.00
ICBM	500	52P8	.00	F	1.00
LCC	200	39P0	.00	F	1.00
NUKSTO	50	39P5	.00	F	1.00
SUBPTS	20	22P1	.36	F	1.00
IRBM	400	11P0	.00	F	1.00
AFBASE	100	10Q1	.79	F	1.00
STORES	430	31P6	.00	M	1.00
FACIL	520	23Q0	.33	M	1.00
FACTOR	1100	14Q0	.49	V	1.00
DEPOS	550	16Q0	.56	M	1.00
NAVAL	130	18P0	.40	M	1.00
POL	1300	10P0	.00	V	1.00
ENERGY	435	18P0	.22	V	1.00
MICBM	150	30	.00	F	1.00

The total number of targets ranges from 6690 to 7040, depending on the year.

Nuclear storage, factory, depots, naval, POL, energy, and MICBM target classes were added to the original database (2:79). All data for these targets are notional.

The number of ICBM and MICBM targets will change from year to year based on the number of each type of system in the Soviet force.

For target type, F stands for Force targets, M for Military targets, and V for Value targets

TABLE 3.4

U.S. WEAPONS BASE

NAME	WHD/WPN	PA	CEP	YLD	DAYALRT	GENALRT
TITAN	1	.5	.7	9.00	.90	.98
MMII	1	.5	.2	1.20	.90	.98
MMIII1	3	.5	.15	.17	.90	.98
MMIII2	3	.50	.12	.34	.90	.98
POSEID	10	.80	.24	.05	.55	.80
TRIDC4	8	.80	.24	.10	.66	.80
B52GRV	4	.60	.60	1.00	.33	.85
B52SRM	4	.60	.20	.20	.33	.85
52HGRV	4	.60	.50	1.00	.33	.85
52ALCM	12	.60	.054	.20	.33	.85
111SRM	4	.60	.20	.20	.33	.85
FB111	2	.60	.20	1.00	.33	.85
B1BGRV	4	.70	.15	1.00	.33	.85
BIBMC	8	.70	.054	.20	.33	.85
MX12A	10	.55	.054	.34	.90	.98
TRIDD5	8	.85	.054	.10	.66	.80
SICBM	1	.70	.05	.34	.90	.98
ATB	12	.75	.05	.5	.33	.85

Except as noted, the source for these figures is (14:162-63)
The number of warheads per bomber is notional, especially in the case of the B1B and ATB.
CEP for bombers and newer weapons such as the Trident D5, MX (with Mk-12A warhead) and the SICBM are notional. However, it is assumed that new weapons will have CEPs in the 100 to 90 meter range.
Bomber alert figures are from (19:53) for generated alert and (23:10) for day to day alert. It is assumed that newer bombers will have the same alert rate. Alert figures for ICBMs are notional. SLBM alert figures are from (23:10 and 13:186)

LEGEND:

TITAN	= TITAN	MMII	= MINUTEMAN II
MMIII1	= MINUTEMAN 3	MM1112	= MINUTEMAN 3 (MK-12A RV)
POSEID	= POSEIDON (C-3)	TRIDC4	= TRIDENT (C-4)
B52GRV	= B-52G (BOMBS)	B52SRM	= B-52 (SRAMS)
52HGRV	= B-52H (BOMBS)	52ALCM	= B-52 ALCM CARRIER
111SRM	= FB-111 (SRAMS)	FB111	= FB-111 (BOMBS)
B1BGRV	= B-1B (BOMBS)	B1BMC	= B-1B ALCM CARRIER
MX12A	= MX (MK-12A RV)	TRIDD5	= TRIDENT (D-5)
SICBM	= SMALL ICBM	ATB	= ADVANCED TECH. BOMBER

Definitions for PA, CEP, YLD, DAYALRT and GENALRT are the same as in Table 3.2

U.S. Target Base

Only force, leadership, and command and control targets were included in the U.S. target base attacked in the Soviet first strike. The assumption is that a surprise Soviet counterforce strike would go against U.S. ICBM's, about 50 SAC home and dispersal bases, submarine ports, and a few key leadership and C^3I sites. Target hardnesses for all classes except ICBMs were assumed to be equal to their Soviet counterparts. ICBM silos were given a hardness level of 2000 psi. (25:60) Table 3.5 gives the complete U.S. target base.

TABLE 3.5

U.S. TARGET BASE

NAME	NUMBER	VULNERABILITY	DIAMETER	TYPE	VALUE
SACBAS	50	10Q3	.79	F	1.00
SUBPTS	10	22P2	.36	F	1.00
LDRSHP	8	13P3	.49	F	1.00
C3I	6	35P7	.00	F	1.00
ICBM	1000	2000	.00	F	1.00

All figures are notional. Except for ICBM silos, U.S. targets are assumed to be of equal hardness to their Soviet counterparts. ICBM hardness from (25:60)
The number of ICBM targets will vary from 174 to 1074 based on the number of U.S. ICBMs.

Probability of Arrival

One critical assumption is weapon system probability of arrival on target. BRIK uses one single number which its authors call "reliability" to cover the various factors of pre-launch survivability, actual weapon system reliability, and probability to penetrate enemy defenses. (2:28-29) In this thesis, the term "probability of arrival" (PA) will be used instead of the original term, which was misleading.

These factors are three of the four elements required to calculate DE. As a convenient framework, DE can be thought of as the product (Probability of pre-launch survival) * (Probability to penetrate enemy defenses) * (Weapons system reliability) * (Probability of Damage). Note that this can also be thought of as calculating the probability of mission accomplishment where the mission is to destroy the target.

Pre-launch survivability is the probability that a weapon survives the first strike. The major factors in pre-launch survivability are the alert status of the weapon system and the time required to get the weapon system out of the target area. This time ranges from seconds in the case of ICBMs to minutes for alert bombers.

Probability to penetrate enemy defenses is effectively 1.0 for ballistic missiles, since no really effective ABM system has been deployed, and it is assumed that none will

be deployed prior to 1995. For bombers, probability to penetrate is based on the number and type of enemy defenses, bomber ECM effectiveness, and crew proficiency.

Weapon system reliability is based on how well the system works. It is the probability that the equipment will function well enough to properly put the weapon on target.

These three factors taken together give the probability of arrival of the weapon on target. Once the weapon arrives, the probability of damage is based on the weapon yield, target hardness, and delivery accuracy.

However, estimates of PA may vary greatly. Remember that PA also takes into account the probability of prelaunch survivability. Experts are widely divided in their PA estimates for ICBM's under attack. It could go from 100% assuming launch on warning to as little as 5-10% assuming a complete ride-out and very accurate Soviet weapons. (22:70) Likewise, the bomber PA estimate can be widely skewed based on one's opinion of their survivability in the base escape phase as well as the probability of penetrating Soviet air defenses. SLBMs have neither the problems of being attacked nor being defended against since they are considered invulnerable to Soviet attack. Therefore their PA was based solely on weapons system reliability.

ICBM PA was based on a 0.62 survival rate for the Soviet attack coupled with an 0.8 reliability rate, for an overall PA of 0.5. (25:18,60)

Bomber PA incorporates three factors, a 0.95 survival rate for alert aircraft, an 0.8 probability to penetrate Soviet defenses (which was adjusted downward from Quanbeck and Wood's figures due to modernized Soviet defenses) and an 0.8 reliability rate for a total PA of 0.6. (19:52,65)

Since SLBM weapons at sea are almost certain to both survive the attack and penetrate defenses, the SLBM PA was based solely on an 0.8 reliability rate. (25:18)

Soviet weapon PAs would not be affected by either U.S. attacks or the minimal U.S. defenses, therefore these figures were based on the weapon reliability figures. (25:16)

Force Posture Assumptions

Another assumption is that U.S. forces will be in generated alert. That is, U.S. forces will be in an increased state of readiness, probably as a result of a crisis situation. The U.S. forces will have a much higher number of bombers on alert and submarines at sea. Since the ICBM force normally maintains a very high alert rate, a small increase in the number of ICBM's will also occur. (6:55)

While many see the generated alert scenario as most likely, some are not so sure. They point to other cases where the U.S. has had strategic warning in a crisis and failed to act. Pearl Harbor is one example. (20:29) Thus, the forces which were built under generated alert will also be evaluated in a day-to-day alert situation, which is the normal U.S. state of readiness.

METHODOLOGY

This section will present the methodology used to determine both the future U.S. force structures and measures of merit for these forces.

Arms Control Schemes

As mentioned in the last chapter, the two arms control agreements were the Reagan Administration's START proposal with a reduction in ballistic missile warheads to around 5000 using a build-down approach, and the five-percent annual reduction in standard weapons stations (SWS) proposed by General Kent. Each proposal was assumed to run for 10 years, from 1985 to 1995, and was evaluated every five years.

Targeting Strategies

To give a broad coverage to the differing types of target objectives, three sets of target priorities were used. These were Leadership, Counterforce, and Countervalue targeting. For a given targeting strategy, each of the four priorities within the set were assigned the same DE goals. All first priority targets had a DE goal of 0.8 in the generated force posture and 0.7 in the day-to-day force posture. Second priority targets had goals of 0.7 and 0.6, third priority targets had goals of 0.6 and 0.5, and fourth priority targets had DE goals of 0.5 and 0.4, respectively.

TABLE 3.6

TARGETING PRIORITIES AND DAMAGE EXPECTANCY (DE) GOALS

TARGET STRATEGY	TARGET CLASSES	DE GOAL (GENERATED)	DE GOAL (DAY-TO-DAY)
LEADERSHIP	LEADERSHIP, C^3I	.8	.7
	NUCLEAR FORCES	.7	.6
	CONVENTIONAL FORCES	.6	.5
	ECONOMIC/INDUSTRIAL	.5	.4
COUNTERFORCE	NUCLEAR FORCES, C^3I	.8	.7
	CONVENTIONAL FORCES	.7	.6
	LEADERSHIP	.6	.5
	ECONOMIC/INDUSTRIAL	.5	.4
COUNTERVALUE	ECONOMIC/INDUSTRIAL	.8	.7
	LEADERSHIP, C^3I	.7	.6
	CONVENTIONAL FORCES	.6	.5
	NUCLEAR FORCES	.5	.4

Table 3.6 is reproduced from Chapter Two to summarize the targeting priorities and goals.

Procedure

This section will cover the actual procedure used for this part of the analysis, it will show in a step-by-step fashion the input requirement, model runs, and output of the analysis. A general flow chart (Figure 3.1) is included to give an overview of this procedure. The procedure used for the 1985 force is slightly different than those used for the 1990 and 1995 forces, mainly because the 1985 force is not constrained by arms control.

FIGURE 3.1

PROCEDURAL FLOW CHART

YEAR	INPUT REQUIREMENTS	ACTION	OUTPUT
1985	Soviet weapon base U.S. targets Constraints: 2 on 1 attack Minimize warheads ICBMs on ICBMs SLBMs on SAC bases No Soviet bombers	Soviet Counter-Force Attack Goal: 0.9 DE on U.S. Force Targets	Soviet weapons used, U.S. weapons killed
1985	Soviet target base (minus ICBMs used) U.S. weapons Constraints: Minimize warheads Minimum DE levels	U.S. Retaliatory Strike Goals: IAW each targeting strategy	DE on Soviet targets Residual weapons Soviet EMT
1990, 1995	New Forces Available	Add new weapons	Forces Available for next allocation
1990, 1995	U.S. Weapons Soviet Targets Constraints: Minimize warheads Minimum DE levels Arms control limit (SWS or RVs) Keep the Triad Build-down requirements	U.S. Attack Allocation Goals: IAW each targeting strategy	U.S. forces required to meet goals DE on Soviet targets Residual weapons Soviet EMT
1990,	Soviet Weapons U.S. targets as determined by U.S. allocation Constraints: As in 1985	Soviet Counter-Force Attack Goal: 0.9 DE on U.S. force targets	Soviet Weapons used U.S. weapons destroyed

1985 Soviet Attack

As mentioned previously, the assumed scenario is a Soviet counterforce strike against U.S. ICBM silos, SAC bomber bases, submarine ports, and key leadership and C^3I targets. The Soviet attack attempts to destroy 90% of these targets. All of these targets had equal priority. The attack was constrained in the following manner:

1) No more than two warheads could be allocated on any single target, because of fratricide problems.

2) Only ICBMs could attack ICBM silos, and only SLBMs could attack bomber bases.

3) No Soviet bombers could be used, since the use of these weapons would lose the advantage of surprise for the Soviets.

4) The allocation minimized the use of Soviet warheads.

The model required the Soviet weapons base of 1985 (Tables 3.1 and 3.2) and the 1985 U.S. target base (Table 3.5), and was run using BRIK with the above constraints. Two measures of merit were produced, the number of Soviet weapons used in the attack and the number of U.S. weapons destroyed in the attack. The U.S. weapons destroyed were calculated under an assumed U.S. ride-out of the Soviet attack and a day-to-day alert posture. Bombers on alert and submarines at sea were assumed to have survived. Survival rates of non-alert bombers, submarines in port, and ICBMs were equal to the survival rates of SAC bases, submarine

ports, and ICBM silos, respectively. These survival rates were determined using the damage expectancy (DE) results of the Soviet attack.

1985 U.S. Attack

The 1985 U.S. response was determined under each of the three targeting strategies and under both day-to-day and generated force postures. This process was repeated for each of the three targeting strategies.

The 1985 U.S. weapon base (Table 3.4) and Soviet target base (Table 3.3) were used. The Soviet target base was modified by reducing the number of ICBM targets available by the number of Soviet ICBMs used in the Soviet counterforce strike, which left 1000 Soviet ICBM silos. The U.S. weapon survival rates were based on the figures discussed earlier in the chapter in the section on Reliability, rather than on actual Soviet first-strike results. This is because the Soviet first-strike results assume a complete U.S. "ride-out" of the Soviet attack. Given the scenario, it is unlikely that the U.S. would "ride-out" the attack.

One constraint was used in the model: Enforce a minimum level of damage on each target class.

This constraint was necessary to insure that at least some of each target class were covered. The underlying assumption was that in every target class there were a few "key" targets which must be covered, and that it was preferable to cover all key targets rather than to attempt to meet

DE goals. The minimum DE requirement for first priority targets was 0.4, 0.3 for second priority targets, 0.2 for third priority, and 0.1 for fourth priority.

Another input requirement was a goal to minimize the number of warheads used. This was the lowest priority goal, and was required by the BRIK model.

The U.S. retaliatory strike was then run using the BRIK model and the previously discussed inputs and constraints. Once the runs were completed using both generated and day-to-day alert postures and all three strategies, the following measures of merit could be obtained:

1) U.S. DE accomplishment.

2) U.S. residual weapons that were not required in the attack.

3) Soviet retaliatory capability, measured in total equivalent megatonnage (EMT). EMT is a measure of a weapon's ability to attack urban targets and is calculated using the formula

EMT = n * y ** (2/3)

where n is the number of weapons having a yield of y. The EMT for each individual weapon class is added together to determine the total EMT. To determine this, the number of Soviet weapons surviving the U.S. strike was calculated in the same manner as the number of U.S. weapons surviving the Soviet strike. Then, these surviving weapons were converted to EMT and summed.

1990 and 1995 Procedures

The procedures followed in 1990 and 1995 were similar to the 1985 procedure, with three important differences. First, new forces had to be added. Second, extra constraints to enforce the arms control agreements were added, and finally, the order of runs was changed, with the Soviet attack being run last since the Soviet attack needed to be based on the U.S. force structure. Each combination of the two arms control proposals and three targeting strategies was used, in both years.

Addition of New Forces

New U.S. weapons systems such as the Peacekeeper ICBM and the Advanced Technology Bomber are assumed to be available in 1990 and 1995. These forces, both new systems and additional "old" systems, were added to the 1985 forces. This gave a U.S. force consisting of both the entire force used the previous time (1985 or 1990) and all possible new systems. New systems available in 1990 and 1995 are listed in Chapter Five (Tables 5.2 and 5.6).

U.S. Allocation and Attack

This new force was used in an attack on the Soviet target base for either 1990 and 1995. The differences between the 1985, 1990 and 1995 Soviet target bases were determined by the number of ICBMs in the Soviet force for that year. In 1990, the number of silo-based Soviet ICBMs declined to 500, and 150 mobile ICBMs (SS-25) were added. In 1995, there

were only 195 Soviet ICBM silos, but 500 mobile ICBMs. See Table 3.1 for details. Unlike 1985, the number of ICBMs required for the U.S. counterforce attack was not subtracted from the number of ICBM targets. This was because the 1990 number of ICBMs required was insignificant (about 25) and the 1995 requirement could range as high as 100% of the force because of the requirement to attack U.S. mobile ICBMs. It was decided that it was unrealistic to expect the Soviets to spend all of their ICBMs to attempt to destroy U.S. mobile ICBMs, but there was no way to determine how many the Soviets would use. In both cases, all Soviet ICBM targets were assumed to be strikable.

Probabilities of arrival (PA) remained constant for weapon systems already in existance. Newer systems, such as the Trident D-5, Small ICBM, B-1B and the ATB had slightly increased PAs to account for increased weapon system reliability, probability to penetrate enemy defenses, and probability of surviving the Soviet attack. See Table 3.4.

With the available U.S. weapons and the Soviet target base for 1990 and 1995, ERIK was run using the following inputs:

1) Minimize the number of warheads used.

2) Enforce minimum DE levels on each target class.

3) Enforce a maximum number of either ballistic missile warheads or SNS, as appropriate for the arms control proposal being used.

4) Restrict all U.S. weapons except B-1Bs and Advanced Technology Bombers (ATBs) from attacking Soviet mobile ICBMs. This was because the probability of kill for ballistic missiles against these targets was extremely low. Probabilities of kill for the bombers against mobile ICBMs were manually input. A complete discussion of the problems of mobile ICBMs will be given later in this chapter.

Two constraints that were considered, but not part of the computer runs were:

1) Maintain the triad of nuclear forces intact. No allocation was allowed which did not include all of the three triad elements of land-based ICBMs, SLBMs, and bombers. In two cases, allocations did not include land-based ICBMs. In these cases, the model was re-run with an additional constraint to use 200 ICBM warheads.

2) Meet build-down constraints. The maximum number of ballistic missile warheads was based on a five-percent annual reduction in these warheads. However, it was still necessary to destroy old weapons based on the number of new weapons used. Each allocation was checked to ensure that the build-down ratios were met. In all cases, these requirements were met without the need for analyst intervention. However, it will be shown in Chapter Five that some weapons must be kept to meet build-down constraints in later years. One possible way of building a build-down constraint in BRIK would be to add a dummy target class, and

force old weapons to be allocated to this class based on the number of new weapons built. The weapons allocated to the dummy class would be the ones to be destroyed.

The U.S. force was determined in the generated alert posture, and evaluated both in the generated and day-to-day postures. The following results were obtained:

1) The U.S. force required to meet the target strategy DE goals in the generated alert posture.

2) The DE accomplishment of the U.S. force.

3) Residual U.S. weapons, which were the difference between U.S. requirements and treaty requirements. That is, if the U.S. requirement to meet all goals was a force of 5000 SWS and the arms control proposal requirement was a maximum of 6000 SWS, then 1000 additional SWS could be maintained and still stay within the treaty limitations. These potential weapons are stated only in terms of how many SWS or ballistic missile warheads are allowed under the treaty, rather than creating an actual reserve force structure. These weapons are not a reserve in the normal sense, because they are neither used in the U.S. allocation nor targeted against in the Soviet attack. They merely represent a potential for increased force levels and capability.

4) Finally, Soviet EMT remaining after the U.S. strike, calculated using the 1985 procedure.

Soviet Attack

Once the U.S. forces for 1990 and 1995 were determined, the Soviet attack on those U.S. forces was made. Using the newly determined U.S. forces, and the estimated Soviet forces for 1990 and 1995, ERIK was run using the same procedures and constraints used in the 1985 Soviet attack. For the 1995 attack, U.S. mobile ICBMs were added to the U.S. target base, and the Soviet missile probability of kill versus the mobile ICBM was manually input.

As in the 1985 Soviet attack, the 1990 and 1995 Soviet attack gave two measures of merit, number of Soviet weapons used in the attack and the number of U.S. weapons destroyed in the attack.

The Problem of Strategically Relocatable Targets (SRTs)

Finally, it was necessary to come up with a method of dealing with SRTs. An SRT is a target which is either mobile or imprecisely located. Because targets such as mobile ICBMs are relatively "soft" giving a high probability of damage if the target is found, the probability of damage is based more on the probability of locating the target than on the probability of damage of the weapon against it. It was assumed that ballistic missile type weapons only were targeted for a specific spot in the SRT's known operating area. Bombers, on the other hand, would fly over the

operating area, and could attack the target if they found it. Basically, the attacking side has no prior knowledge of the location of the SRT other than its operating area.

For a mobile ICBM (the only type of SRT considered) it was assumed that the missile/transporter had a hardness level of 30 psi. Further, it was assumed that the system would have about a 100-square-mile operating area. (15:20) It can be shown, that for weapons in the 500 kiloton to 1 megaton range, the lethal area of the weapon versus a 30-psi target is from two to three square miles. If the 100-square-mile area was bombarded in a systematic fashion, the probability of any single weapon killing the target is 0.02 to 0.03. Since most ICBM warheads are in the 500 kiloton or below range, 0.02 was used as the SSPK for missiles going against mobile ICBMs.

As mentioned earlier, bombers are assumed to fly over the known area of operation. While the optical (and radar) horizon for a bomber flying at any altitude is in excess of seven miles, it is assumed that the actual area that a B-1B bomber can search and reliably destroy a SRT is limited to one and one half miles to either side of track due to the problems of surviving the nuclear environment. The ATB is assumed to do a bit better, with a search area of two miles to either side. Note that these figures are purely notional and do not in any way reflect U.S. capability or tactical doctrine.

Therefore, assuming the mobile ICBM is in a 10 mile by 10 mile area, a B-1B bomber could search 30 square miles (3 by 10) or 40 square miles for an ATB, of the 100 mile area. Thus the probability of detection is 0.3 or 0.4, respectively. If weapon accuracies are less than 200 meters, the SSPK once the target is discovered is effectively 1.0. Thus the SSPK for a bomber going against a SRT was input as 0.3 for B1Bs and as 0.4 for ATBs using the newly added manual SSPK input feature of the BRIK model.

SUMMARY

This chapter covered the details of the assumptions and methodology used in this study. The assumed scenario of a Soviet counterforce first strike followed by U.S. retaliation was developed, and details of U.S. and Soviet weapon and target characteristics were developed. Particular attention was paid to the probability of arrival, which was the product of up to three separate estimates.

The methodology for the analysis was then discussed. It was shown how BRIK would be used to generate U.S. force structures along with various measures of force stability and effectiveness. It was noted that certain constraints -- the number of warheads required to be built down and keeping the triad intact -- were not put into the model and required the analyst to check each force structure created by the model. Finally, a method for dealing with strategically relocatable targets was developed in detail.

The next chapter will cover the BRIK model itself and will give an overview of the model features along with various changes that were made.

CHAPTER FOUR: THE BRIK NUCLEAR EXCHANGE MODEL

OVERVIEW

This chapter will give an overview of the BRIK nuclear exchange model. BRIK's important features, strengths and weaknesses will be discussed. Also, several changes to the model, including model corrections, new features, and portability, will be covered.

Readers already familiar with BRIK can skim the first part of the chapter on BRIK's features. Those not familiar with the model and who wish a more complete discussion of the mathematical formulation are referred to Bunnell and Takacs' Thesis. (2) Of course, readers who are only concerned with the analysis may skip to the next chapter which presents the results of the analysis.

REVIEW OF BRIK

BRIK is a pre-emptive, linear goal-programming nuclear exchange model written by Robert Bunnell and Richard Takacs as an AFIT masters thesis. (2) The BRIK model offers some important features to the analyst, but, has not been tested or validated (or used, for that matter) by anyone but the authors. Some of the characteristics of the model are as follows.

Features

Weapons and Targets

Up to twenty classes of weapons and twenty classes of targets may be used. (2:vii) Each weapon is described by the number of warheads per weapon, CEP, yield, weapon reliability, and alert rates. Target classes contain the target hardness, either using the physical vulnerability (VNTK) system or psi hardness, target area, target type, either military (m) value (v) or force (f), and weapon parameters (for force targets only). (2:28-29) The analyst can allow any weapon to be allocated against any target, or he may designate inappropriate weapon/target combinations. (2:126)

Targets may be given priorities ranging from 1 to 7, and percentage damage expectancy (DE) goals may be given either for individual target classes or by military, force, and value classes, as defined by the analyst. (2:118,122) Once the weapons, targets, and DE goals have been entered, the analyst has several options.

Objective Functions

The analyst is able to use one of three objective functions in his analysis. They are:

1) Attempt to meet DE goals using the available arsenal. This objective function was used for the study.

2) Meet DE goals, building new weapons if necessary.

3) Convert the DE goals to upper bounds. That is, get no higher than the DE goal. The analyst must use the

various hedging options described below to force BRIK to allocate weapons. If no hedges are used, BRIK will not allocate weapons. (2:124-125)

Extreme Goal

Once the type of objective function has been selected, the user must select an extreme (last priority) goal. This forces the model into a single, optimal solution if all the higher priority goals have been met. The types of extreme goals are:

1) Minimize the number of warheads used.

2) Minimize megatonnage used.

3) Minimize countermilitary potential used.

4) Minimize total equivalent megatonnage used.

5) Use as much of the remaining arsenal as possible. (2:125-126)

Hedging

Once this has been done, and inappropriate weapon/target combinations have been entered, the user is able to input his own hedges to customize the allocation. There are seven types of hedges in BRIK.

1) Enforce a minimum DE on a particular target class.

2) Enforce a minimum DE on a particular class using a specific set of weapons.

3) Enforce an upper level of DE on a target class using a specific set of weapons.

4) Restrict the number of weapons that can be allocated on a target class.

5) Custom-design a constraint.

6) Enforce a minimum DE on a set of target classes.

7) Restrict the number of weapons which can be allocated to each target in a particular class. (2:127-130)

Order of Goals

In BRIK, the order in which goals are met differs depending on which objective function is used. For type one objective functions, the order is:

1) Weapon and target constraints.

2) Hedges (if any).

3) DE goals for target classes, in order of priority.

4) The extreme goal.

For the type two objective function, the order is:

1) Target constraints.

2) Hedges.

3) DE goals for target classes.

4) Minimize the number of new weapons built.

5) The extreme goal.

For type three objective functions, the order is quite different:

1) Weapon constraints.

2) Target constraints.

3) Hedges.

4) Extreme goal. (2:60-65)

Comments on Hedging

With that in mind, a few comments about hedging need to be made. Type One and Two hedges are very similar, in that both enforce minimum levels of DE, but differ in that Type Two hedges restrict the weapons which may be used. Note that these minimum levels will be met (or attempt to be met) prior to allocating any weapons to meet the DE goals.

Type Three hedges limit the damage on a target class by a particular set of weapons. If it is desired that no more than 50% of the damage on target class "factory" be from SLBMs, for example, this type of hedge would be used. (2:128)

Type Four hedges place an upper limit on the number of weapons from a class that can be allocated on a target class. This is useful for cases in which a target class "soaks up" all of the weapons in a class. This could happen if a weapon had a very low probability of kill against a certain target. The target class would then use up an inordinate number of weapons. If these weapons should be used on other classes, a Type Four hedge can insure that some weapons are left for other classes. (2:128)

Type Five hedges are for the advanced analyst. In theory, just about any type of constraint may be built. I this analysis, Type Five hedges were built to give a maximum number of total weapons that could retained or built for the 1990 and 1995 U.S. forces. Thus, the model then would

choose from all the available weapons to meet DE goals up to the maximum number of weapons allowed under the particular arms control scenario. Two examples, one limiting ballistic missile warheads, and one limiting SWS are presented. For simplicity, two weapons classes, consisting of 100 "icbm" and 100 "slbm" and one target class "type one" are used. The limit in each case is 1000 SWS or warheads. Weapon characteristics are as follows:

Each icbm has an alert rate of 0.98, 10 warheads, and counts for 12 SWS. Let X_{11} be defined as the number of icbm warheads used on target type one.

Each slbm has an alert rate of 0.8, eight warheads, and counts for nine SWS. Let X_{21} be defined as the number of slbm warheads used on target type one.

For the limit on ballistic missile warheads, the constraint would take the following form:

$$(1/0.98)*(X_{11}) + (1/0.8)*(X_{21}) \text{ .LE. } 1000$$

The reason that the number of warheads used is divided by the alert rate is because BRIK only allocated weapons on alert. For example, if only icbm weapons were used, BRIK would only allocate 980 (1000 * 0.98) warheads. Thus the number used must be divided by the alert rate to give the number of warheads in the arsenal.

In the case of the limit on SWS, the formulation is similar, except that the number of SWS per warhead must be factored in, since the limit is now in terms of SWS:

$$(1/0.98)*(12/10)*(X_{11}) + (1/0.8)*(9/8)*(X_{21}) \text{ .LE. } 1000$$

If more weapon or target classes are added, these constraints must be expanded to cover all possible weapon/target combinations. A Type Five hedge covering all combinations of 20 weapon classes and 20 target classes would have 402 terms!

Type Six hedges, which enforce a minimum DE level against a set of target classes, should be used with caution because they may not give the analyst the desired results. If one class has a higher Single Shot Probability of Kill (SSPK) than the others in the set, all or most of the available weapons will be allocated to the class with the highest SSPK. For example, if a Type Six hedge was used to enforce a minimum DE of 0.3 on a set of classes which included 70 ICBM silos with a SSPK of 0.1 and 30 factories which had a SSPK of 1.0, all available weapons would be allocated against the factories, while the silos would be left untouched. (2:130) If what the analyst really wanted was to destroy 30% of the factories and 30% of the ICBM silos, he must use individual Type One hedges.

Finally, Type Seven hedges limit the number of weapons that may be used on each member of a target class. For example, if the analyst wanted to limit the number of ICBMs

which could be allocated against each ICBM silo to two, because of fratricide effects, a Type Seven hedge would be used. (2:130)

Output and Sensitivity Analysis

Once all the hedges are input (up to 20 hedges may be used), the program then performs the allocation. When the allocation is finished, the results are sent both to the screen and a file. Finally, the analyst may re-run the problem for sensitivity analysis.

Sensitivity analysis involves re-doing the same problem, but changing some of the parameters. BRIK allows the analyst to change DE goals, weapon availabilities, target weights, and weapon and target parameters. This process can be continued as many times as desired. (2:134-137)

As one can see, BRIK has the potential for being an extremely useful program. Howver, it does have some limitations.

Limitations

BRIK is an aggregrated model. That is, all weapons and targets are represented by classes rather than individual specific target installations or sortie numbers. Each weapon or target in a class is identical in all characteristics to any other member of its class. For example, all members of class "Factory" are identical, and all members of class "B52" have an identical probability of kill against factories. (2:27)

Also, there is no individual target breakdown. If more than one weapon class is allocated against a single target class, it is not stated which weapons went against which targets in the class. (2:27)

BRIK does not necessarily give integer solutions. No attempt was made to keep weapons or targets in whole units. (2:27) For large problems, this is not much of a limitation, although there may be cases where simply "rounding off" the solution will not yield an optimal solution, and may not even yield a feasible solution. However, if small problems are used, BRIK may well allocate 4.08 weapons on five targets! If the number of weapons is large compared with the number of targets, type seven hedges could be used to drive an integer solution. Again, whether or not this is a problem will depend on the exact scenario, as well as the analyst's judgement.

In keeping with the aggregated nature of the model, there are no footprint or range restrictions. It is assumed that any weapon can reach any target. ICBM RVs are in reality restricted in the degree of dispersion, or "footprint" that a single missile's payload can cover. Likewise, some weapon systems, like FB-111s and ALCMs, are limited by their range from reaching all possible targets in the Soviet Union. BRIK does not deal with these restrictions. (2:27)

Only prompt damage effects are used. BRIK does not calculate damage resulting from radiation, neutrons, or thermal effects. Only the blast and cratering phenomena are modeled. (2:27)

Collateral damage is not modeled. Again, this is a result of the agregated model. Some targets are in fact located very near to each other, and one weapon could destroy them both. However, BRIK requires that one weapon be expended for each target covered. (2:28)

Fratricide effects are not considered. It is possible that subsequent warheads on a target that has already been attacked could be destroyed by the effects of the first weapon. However, BRIK does not take these effects into account. (2:28)

BRIK also assumes that the location of each target be known. Strategically relocatable targets (SRT) could not be dealt with in the original model. (2:29) However, a new feature (manual input of SSPKs -- to be discussed later) makes it possible to handle these targets using the method discussed in Chapter Three.

Time is not explicitly modeled. Some weapons in an actual exchange will detonate before others, and some targets will be "time urgent", requiring prompt attack. Unless hedges are used to force the allocation of certain weapons on certain targets, BRIK will not consider time as a factor. (2:29)

Also, BRIK models a one-sided exchange. If one side is retaliating to the other side's attack, the analyst must determine the results of the first attack before starting the second attack. That is, if "red" strikes first, the number of surviving "blue" weapons and the number of remaining red targets must be input by the analyst, either through reduced weapon/target availability or reduced weapon reliability. (2:29)

Differences in defenses are not considered. Some targets will be point defended, while others will not. BRIK does not consider the differences in attacking the two. (2:29)

Finally, command and control are not modeled. No attempt is made to consider the effect of the loss or disruption of command and control elements. (2:20)

CHANGES TO BRIK

In keeping with the secondary purpose of this thesis, some changes were made to the model to enhance BRIK's effectiveness. These changes were in three major areas -- new features, error corrections, and increased portability.

New Features:

One of the major changes was to add the capability for the analyst to explicitly define the Single Shot Probability of Kill (SSPK) for weapon/target combinations. The original model based its SSPK calculation solely on target hardness, weapon probability of arrival, and CEP. It became necessary to deal with the cases when the SSPK function in the model

did not take into account all the relevant factors. One example of such a case is SRTs. Since these targets are mobile, there is an additional factor in the SSPK function, that of the probability of finding the target. For a relatively soft target, like a mobile ICBM, if the target can be located, its probability of survival is near zero (assuming that it does not move before the weapon arrives). Thus, the SSPK is based more on the probability of detection than the actual weapon/target interaction. The ability to manually insert SSPK values for these targets gives the analyst the ability to bring SRTs into the problem.

Also, the SSPK function was updated to be more accurate for targets with psi hardness greater than 1000. The lethal radius equation used by Bunnell and Takacs has been noted to be only valid up to 1000 psi. (4:214) The formula for lethal radius when hardness exceeds that value is:

LR= 2.62*yield**(1/3)/(psi**(1/3)) (4:214)

Batch job capability was also added. It was discovered that once the model had been used a few times, it became very tedious to use the "menu-driven" format. Especially for cases in which a very large hedge was added (i.e., a type five hedge with 292 entries) this became intolerable. An option now exists to both read from and write to user designed files. While this option is fairly crude (the input file is merely a complete listing of all the commands used in an interactive session), it decreased the start to

finish time of a run to under 30 seconds. Possible improvements would involve writing an "expert user" mode which would eliminate or reduce the menus, or streamlining the input file requirements and suppressing the vast majority of the output file data. Presently, everything that the interactive user sees on the screen is sent to the output file, about 2100 lines of which only about 100 are useful.

Corrections

A few typographical errors slipped through in the original model. These caused unpredictable results and occasionally caused the model to abort execution. Several "o"'s were replaced by "0"'s as well as a few variable names which were mis-typed in the subroutines. One important example is the "r95" variable, which gives the size of the target, was mistakenly entered in a subroutine as "f95". (2:218) The result of this error was that all targets would be treated as point targets even if they were area targets in that particular subroutine.

Portability Changes

BRIK was written in Fortran-77 and used the Partitioning Algorithm for Goal Programming (PAGP) so that it might be easily transportable. When the program was moved to the CDC Cyber computer because of problems with the VAX computer on which it was developed, some things had to be changed.

First, non-ANSI standard usages had to be corrected. In particular, the way that the WPNAME and TGTNAM character

arrays were declared had to be changed. Also, some minor changes in the format statements had to be made. Finally, a statement redefining a DO-variable in a DO-Loop had to be removed.

Input and Output channels were also rigorously defined. The VAX, like most Fortran systems, defaults to unit five being the standard (keyboard) input and to unit six being the standard (screen) output. However, the CYBER, like a few other machines, does not default to those values. Units five and six are now defined in the program itself as the input and output, respectively. This method works both on systems where these are default values and on systems where they are not.

Finally, the memory requirements had to be trimmed. The VAX is a "virtual memory" machine, which basically means that there is no effective memory limit. However, the CYBER, like many other machines, has a definite maximum memory size. As written originally, BRIK was just too big to run on the CYBER.

The use of an overlay solved the problem. The original BRIK used two large arrays, AIJ and TE, in different sections of the model for the same data. The data from the AIJ array was read into a separate file, then read into the TE array along with the necessary auxiliary variables to determine the allocation. Basically, the AIJ and TE arrays were combined into one array. Once the AIJ section is complete,

the TE section takes over, but now they both use the same space, which saved enough space for the program to sucessfully run.

Once these changes had been made, the program performed identically on the VAX and CYBER. There was one important difference -- speed. Compile time went from hours on the VAX to about two minutes on the CYBER. Run times also decreased markedly, going from hours down to 20 seconds using the batch mode. For those interested in updating the original version of BRIK to version 2.0, or in using the model on different machines than the VAX, a line by line listing of changes is available in Appendix A.

SUMMARY

This chapter covered the BRIK goal-programming nuclear exchange model. First, the model as written by Bunnell and Takacs was discussed, and its strengths and weaknesses reviewed. Important additions to the model, such as the ability for the analyst to selectively input SSPKs, an updated SSPK function, and batch job capability were outlined. Next, several corrections to BRIK were noted, and finally, changes were made to the model to enhance its portability to other computers.

The next chapter will discuss the results of the analysis and their assessment.

CHAPTER FIVE: RESULTS AND ASSESSMENT

OVERVIEW

This chapter presents the completion of the systems analysis approach for the problem of selecting which of two arms control proposals to use. The final elements to be covered are the presentation of the model results and the assessment of results with respect to the established criteria.

After a brief review of the measures of merit established in earlier chapters, the evolution of U.S. strategic forces under all combinations of arms control proposals and targeting strategies will be shown. Important characteristics and differences will be pointed out. Next, the evolution in U.S. capabilities will be discussed. Soviet capability in both first and second strike roles will then be covered. Next, several important reasons for differences in U.S. capabilities and forces will be explored. Finally, some pertinent observations for actual nuclear forces will be discussed.

REVIEW OF CRITERIA

This section will review the criteria used in the analysis. The measures of merit fall into two basic classes, measures of stability and measures of capability.

Measures of stability fall into two further categories, crisis and strategic. Crisis stability measures have two basic components, the number or percentage of U.S. weapons

surviving a Soviet first strike and the number of Soviet weapons needed to carry out the strike. Taken alone or in combination, these numbers can show what can be gained or lost in a first strike situation. Also, the number of U.S. weapons surviving the Soviet attack is an important measure of force survivability.

Strategic stability is measured in terms of second strike capability. As long as sufficient second strike capability remains, the Soviets should still be deterred from attack, even if they could change the nuclear balance in a first strike. The measures of second strike capability are DE accomplishment for the U.S. and Equivalent Megatonnage (EMT) surviving the U.S. strike for the Soviets.

Since stability is largely determined by capability, the same measure (DE) is used for U.S. capability. An additional measure of residual weapons shows force capability in a sustained war-fighting environment.

EVOLUTION OF U.S. NUCLEAR FORCES

1985 Force

The baseline 1985 force is shown in Table 5.1. The source for this force is (12:162-3). The 1985 U.S. force has 7481 ballistic missile warheads and 12551 SWS.

1990 Force: New Systems and Limitations

Table 5.2 gives the new systems available in 1990. Titan ICBMs were unavaliable due to their planned retirement.

TABLE 5.1

U.S. FORCES IN 1985

Weapon Name	Number of weapons or Aircraft	Warheads/SWS per Weapon
Titan	37	1/7.6
Minuteman II	450	1/1.4
Minuteman III	250	3/3.0
Minuteman III (Mk-12A)	300	3/3.0
Poseidon	304	10/14.0
Trident (C-4)	288	8/8.0
B-52G Gravity/SRAM	67	8/10.0
B-52H Gravity/SRAM	90	8/10.0
B-52G ALCM	84	12/20.0
FB-111	60	6/3.0

TABLE 5-2

1990: NEW SYSTEMS

Weapon Name	Number of Weapons or Aircraft	Warheads/SWS per Weapon
B-1B	100	12/20
MX (Peacekeeper)	100	10/10
Trident (D-5)	48	8/8
B-52 ALCM	90 (Additional)	12/20
Trident (C-4)	196 (Additional)	8/8

The 1990 limits were 5789 for ballistic missile warheads and 9712 for SWS.

1990 Force: Leadership Targeting

Applying both arms control proposals gave the same force for leadership targeting in 1990, as shown in Table 5.3. Please note that the total for this and subsequent charts may be slightly off due to rounding.

TABLE 5.3

1990 LEADERSHIP TARGETING FORCE

Weapon Name	Number of Weapons or Aircraft	Warheads/SWS per Weapon
Trident (C-4)	365	8/8
B52 ALCM	134	12/20
B1B	100	12/20
Peacekeeper	89	10/10
Trident (D-5)	48	8/8
		Total 4194/8073
		Limit 5789/9712
		Residual 1595/1639

At least 1170 of the allowable ballistic missile warheads must be retained in this force to be built down for the 1995 force. This is because (as will be shown) 226 Small ICBM and 2304 SLBM warheads will be added in the 1995 force, requiring 3682 warheads to be built down. However, only 2512 Peacekeeper and Trident C-4 warheads are retired. Therefore, 1170 additional warheads must remain in the 1990 force.

1990 Force: Counterforce Targeting

This was the only 1990 targeting strategy that created different forces for the two arms control agreements. The only difference between the two forces is the number of Trident C-4 missiles. Table 5.4 gives the complete breakdown.

TABLE 5.4

1990 COUNTERFORCE TARGETING FORCE

Weapon Name	Number of Weapons or Aircraft	Warheads/SWS per Weapon
Trident (C-4)	465 (START)	8/8
	391 (Kent)	
B52 ALCM	157	12/12
B1B	100	12/12
Peacekeeper	100	10/10
Trident (D-5)	48	8/8
FB111 (Gravity)	60	2/1
	Total	5104/9712
	Limit	5789/9712
	Residual	685/0

As in the Leadership targeting force, 530 RV's are required to be maintained to meet the 1995 build-down target.

TABLE 5.5

1990 COUNTERVALUE FORCE

Weapon Name	Number of Weapons or Aircraft	Warheads/SWS per Weapon
Poseidon	101	10/14
Trident (C-4)	480	8/8
B52 ALCM	52	12/20
B1B	100	12/20
Peacekeeper	51	10/10
Trident (D-5)	48	8/8
	Total	5744/9188
	Limit	5789/9712
	Residual	45/524

1990 Force: Countervalue Targeting

The 1990 Countervalue force relied heavily on SLBM weapons. It was the only force to keep some Poseidon missiles, and the only force to reduce the number of ALCM carrying B52s from 1985. Table 5.5 shows the force.

Unlike the other 1990 forces, no additional warheads were required to meet future build-down targets.

TABLE 5.6

1995 NEW SYSTEMS

Weapon Name	Number of Weapons or Aircraft	Warheads/SWS per Weapon
ATB	125	12/16
SICBM	700	1/1
Trident (D-5)	288 (Additional)	8/8
Poseidon	-128 (De-commissioned)	10/14

1995: New Forces and Limitations

Table 5.6 gives the additional weapons systems available in 1995. This table also contains a mandatory reduction in the number of Poseidon missiles. This is because the planned de-commissioning of Poseidon hulls is scheduled to begin in 1993, at a rate of about three per year. (13:169) Assuming that eight boats will have retired by 1995, a reduction of 128 Poseidon missiles would be required. However, no 1995 force used any Poseidon missiles.

The arms control limits in 1995 were 7515 SWS under Kent and 4479 ballistic missile warheads under START.

TABLE 5.7

1995 LEADERSHIP TARGETING FORCE

Weapon Name	Number of Weapons (START)	Number of Weapons (Kent)	Warheads/SWS per Weapon
Trident (C-4)	176	127	8/8
Trident (D-5)	336	336	8/8
B1B CMC	92	92	8/13.3
SICBM	226	589	1/1
ATB	125	125	12/16
		Total	4322/7515
		Limit	4479/7515
		Residual	157/0

1995 Force: Leadership Targeting

Table 5.7 shows the 1995 Leadership targeting force under both Kent and START.

1995 Force: Counterforce Targeting

As in 1990, the Kent proposal has proven to be more restrictive. The ability under the START proposal to keep as many air-breathing weapons as desired makes a large difference in forces. Table 5.8 shows the differences.

1995 Force: Countervalue Targeting

The original allocation for countervalue targeting under both arms control proposals did not include any land-based ICBMs. Since one of the implicit constraints of the problem was to keep the Triad intact, 200 SICBMs were forced into the solution. These extra ICBMs did not degrade the capability of either force in the area of DE accomplishment. This was because the weapons which the SICBM replaced had

similar characteristics. Again, the major difference between the two forces was a trade of bomber weapons in the START force for RVs in the SWS force. Table 5.9 gives the forces.

TABLE 5.8

1995 COUNTERFORCE TARGETING FORCES

Weapon Name	Number of Weapons (START)	(Kent)	Warheads/SWS per Weapon
Trident (C-4)	177	12	8/8
Trident (D-5)	336	336	8/8
B52 ALCM	23	--	12/20
FB111 Gravity	--	60	2/1
B1B	100	100	12/20
SICBM	378	676	1/1
ATB	125	125	12/16
		Total	4479/7515
		Limit	4479/7515
		Residual	0/0

TABLE 5.9

1995 COUNTERVALUE TARGETING FORCES

Weapon Name	Number of Weapons (START)	(Kent)	Warheads/SWS per Weapon
Trident (C-4)	199	319	8/8
Trident (D-5)	336	336	8/8
B1B Gravity	48	--	4/6.7
B1B CMC	100	--	8/13.3
SICBM	200	200	1/1
ATB	125	114	12/16
		Total	4479/7264
		Limit	4479/7515
		Residual	0/251

This completes the different force structures. The next section will cover the capabilities of these various force structures.

EVOLUTION OF U.S. CAPABILITY

1985 Force

The 1985 force was evaluated using all three targeting strategies for both generated and day-to-day alert. A single measure of merit, total damage expectancy as a percentage of DE required to meet all targeting goals was used. This was calculated as in the following example:

Assume that there are two classes of targets. 300 targets in target class one and 400 targets in class two are required to be destroyed to meet all DE goals. If 300 class one targets and 300 class two targets are destroyed, the percentage of DE covered (refered to subsequently as total DE) is 600/700 or 0.857. Other types of value functions, of which a total DE weighted by target priorities would be one example, could also be used. See Appendix B for the complete listing of data used for all total DE calculations.

For the generated force, neither the leadership nor the counterforce strategy were able to meet all DE goals, having total DE's of 0.531 and 0.444, respectively. Also, neither one of these forces had any residual weapons available. The countervalue strategy however, achieved 1.0 total DE with

about 90 RVs or 1170 SWS unused. The difference was because the countervalue strategy primarily used ballistic missiles to achieve targeting goals.

For the rest of this thesis, the terms "leadership capability", "counterforce capability", and "countervalue capability" will refer to the capability of the forces designed to attack leadership, counterforce, or countervalue targets, respectively. Additionally, the terms, "leadership force", "counterforce force" and "countervalue force" will represent the forces generated to attack these target sets.

As expected, total DE dropped significantly when forces were in the day-to-day alert posture. Leadership capability went to 0.451 DE, counterforce capability dropped to 0.436 DE and countervalue capability was a respectable 0.837 DE. DE goals for the day-to-day alert posture were reduced by 0.1 for all target classes because of the smaller number of weapons available.

Leadership Capability

Figure 5.1a gives the total DE accomplishment from 1985 to 1995. Leadership capabilities showed essentially no difference between the two proposals. Total DE rose to 1.0 in 1990 and remained there in 1995 for the generated force. The day-to-day DE accomplishment went to 0.749 DE in 1990 and rose slightly to 0.801 in 1995. Figures 5.2a and 5.2b show the number of residual warheads or SWS available.

FIGURE 5.1 U.S. TOTAL DE ACCOMPLISHMENT

Generated (START) ———
Day-to-day (START) - - - -
Generated (Kent) ━━━
Day-to-day (Kent) ▬ ▬ ▬ ▬

Note: Both START and Kent plans gave the same results where only one set of lines is used

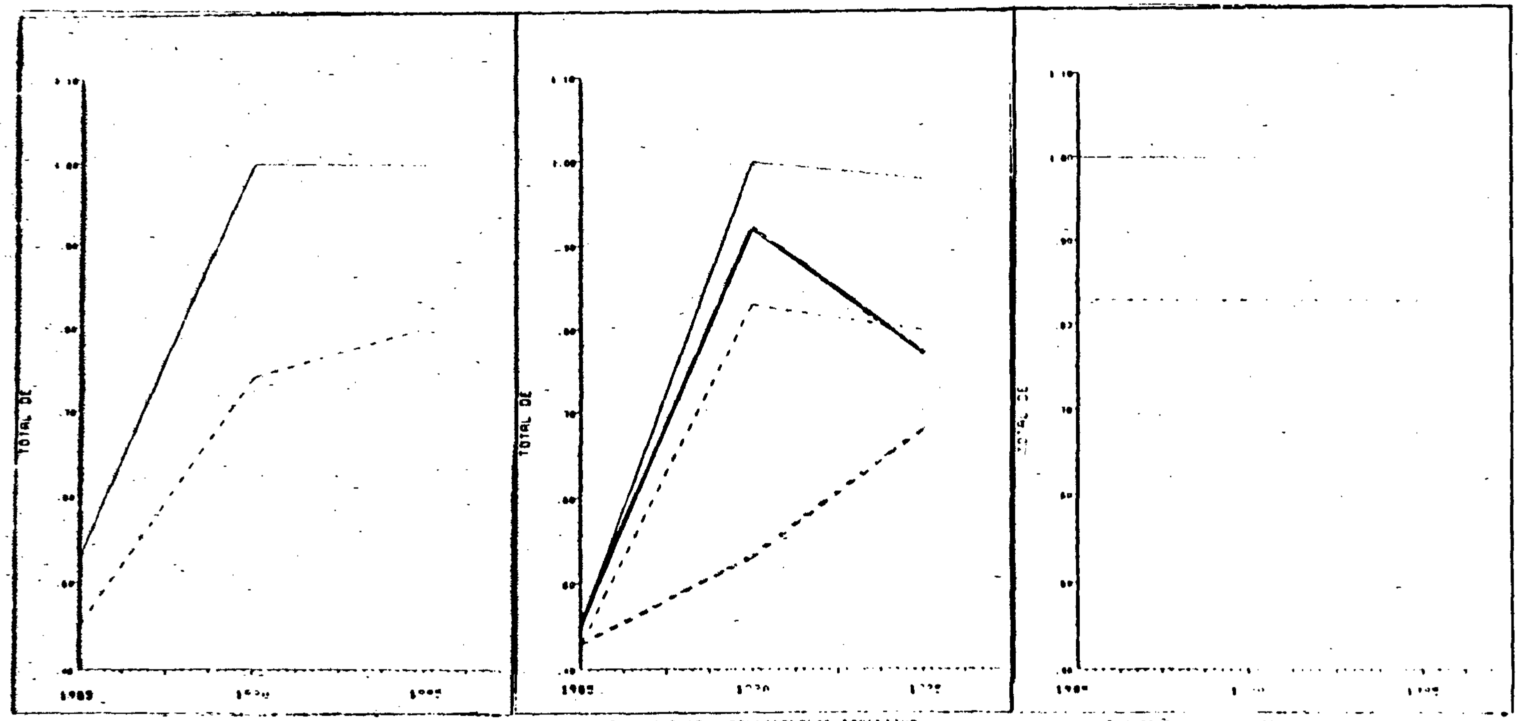

FIGURE 5.1A: LEADERSHIP TARGETING FIGURE 5.1B: COUNTERFORCE TARGETING FIGURE 5.1C: COUNTERVALUE TARGETING

Counterforce Capability

Figure 5.1b shows that as in the leadership force, counterforce capability improved markedly in 1990. Under the START plan, total DE rose to 1.0. For General Kent's proposal, accomplishment rose to a still quite high 0.917. Unlike the other targeting strategies, percent DE dropped in 1995. It declined slightly under START and rather sharply for Kent's proposal.

The day-to-day accomplishment followed a similar pattern. START forces rose to 0.829 and declined in 1995. Under General Kent's proposal, however, total DE rose slightly to 0.535 in 1990 and continued to rise to 0.686 in 1995.

The reserve situation was also sharply different. Figure 5.2b shows that no residual SWS were available under Kent's plan for either 1990 or 1995. Figure 5.2a shows the residual RVs under START.

Countervalue Capabilities

Figure 5.1c shows how countervalue capability remained unchanged either by year or arms control proposal. Generated capability was 1.0 in all cases and day-to-day capability remained at 0.83 DE. The residual weapon pictures were quite different, as shown in Figures 5.2a and 5.2b, with General Kent's proposal showing larger numbers of potential weapons in all cases.

FIGURE 5.2: RESIDUAL WEAPONS (START AND KENT)

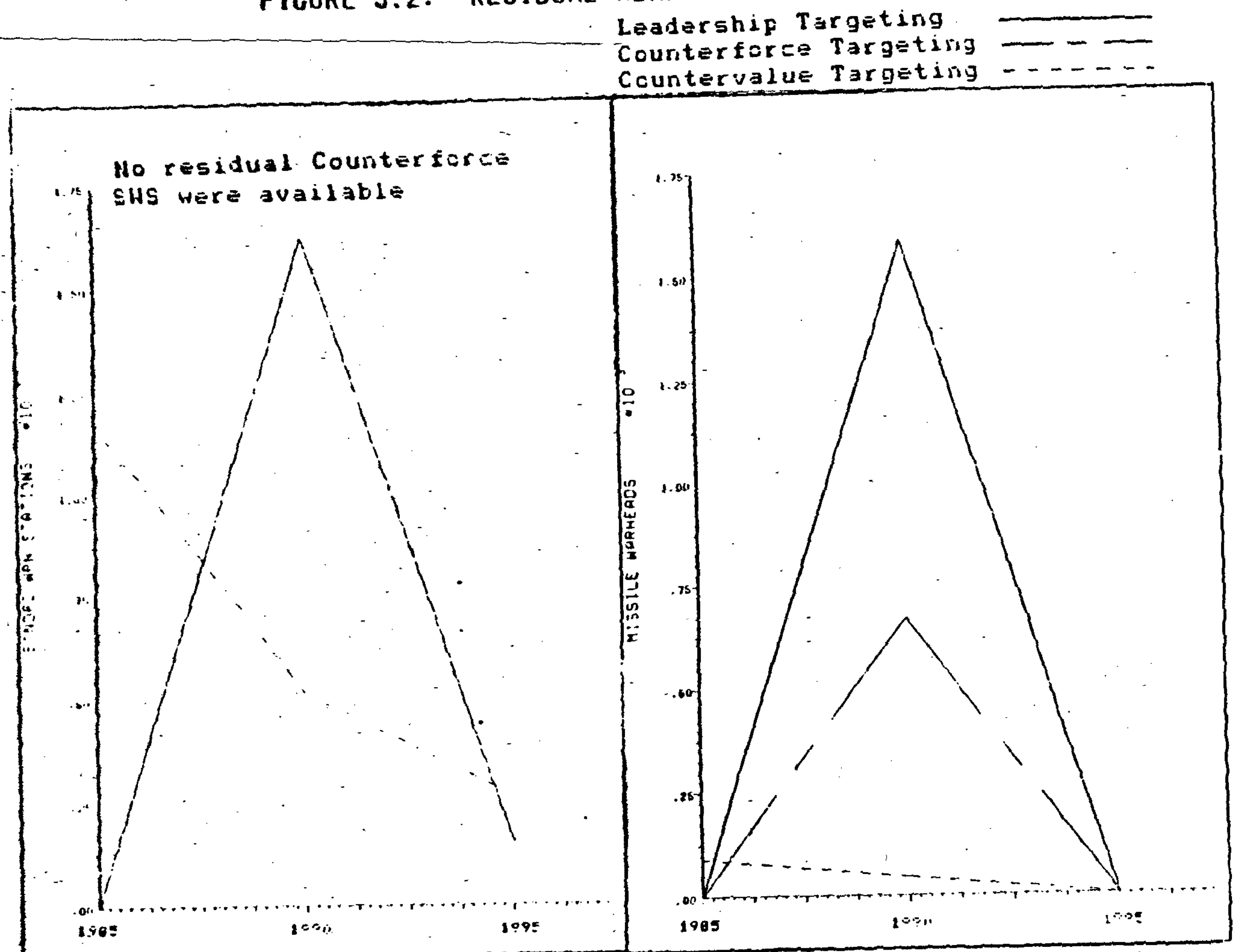

FIG 5.2B: RESIDUAL ICBM/SLBM WARHEADS (START)

This completes the discussion of U.S. capability. The next section will cover the Soviet capabilities in both first and second strikes.

SOVIET CAPABILITIES

First Strike Capability

Figures 5.3a and 5.3b indicate that in any measure of first strike capability, a clear pattern emerges. For all combinations of arms control proposals and targeting strategies, the Soviet capability will increase markedly in 1990 and decrease markedly in 1995.

In 1985, only about 56% of U.S. warheads can be expected to survive a Soviet surprise attack. In 1990, this drops slightly to about 50%, and increases in 1995 to between 58% and 69%, depending on targeting strategy and arms control proposal. However, the number of Soviet weapons required for the surprise attack changes markedly. Presently, 27% of the total number of Soviet warheads would be required for an attack. In 1990, this number drops to 4.8%. Figure 5.3c shows that the Soviet-U.S. exchange ratio, which is defined as the percentage of Soviet warheads used divided by the percentage of U.S. warheads destroyed, rises from 1:2 to more than 1:10. Similar calculations using total warheads, ICBM warheads, and percentage of ICBM warheads give similar results.

FIGURE 5.3: CRISIS STABILITY MEASURES

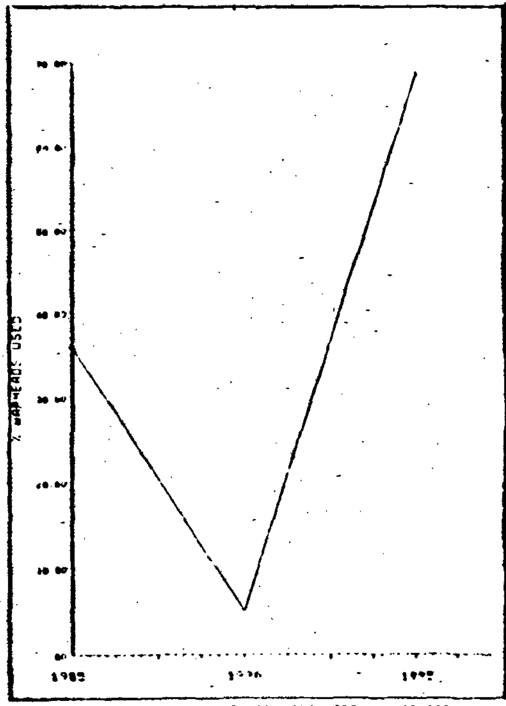

FIGURE 5.3A: SOVIET WARHEADS USED IN 1ST STRIKE

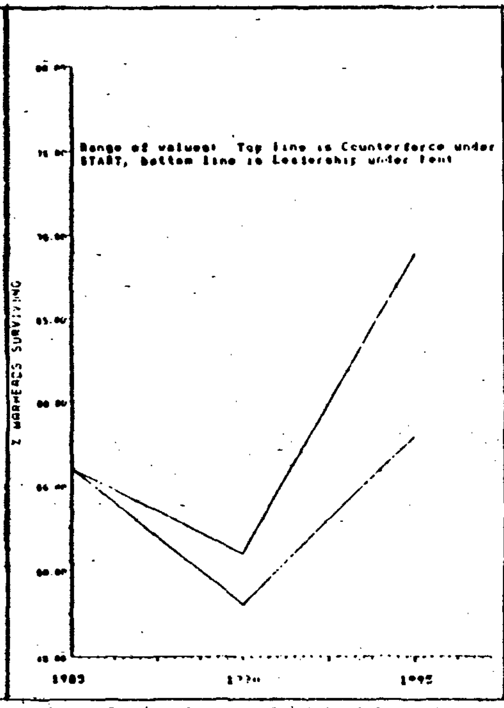

FIGURE 5.3B: U.S. WHDS SURVIVING FIRST STRIKE

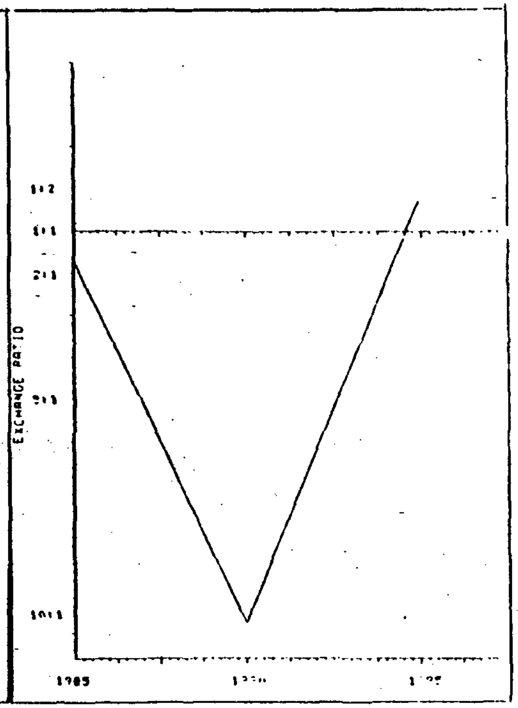

FIGURE 5.3C: SURPRISE ATTACK EXCHANGE RATIO

By 1995, this balance has shifted radically. The introduction of the SICBM now requires the Soviets to spend almost 70% of their total force (100% of all ICBM and SLBMs) to destroy about 60% of the U.S. force. This drives the exchange ratio from 1:10 in the Soviet's favor to about 1.7:1 in the U.S. favor. If only ICBMs are counted, the ratio goes up to 50:1 or more in the U.S. favor.

One factor that could change the 1990 exchange ratio is the deployment of the allowed residual weapons. This is particularly true for leadership targeting. A simple calculation will give a good approximation of the benefit gained by these weapons. For example, about 1600 additional ballistic missile warheads or SWS are available to the leadership force in 1990. These could translate to about 550 Minuteman III missiles or a mixture of Minuteman II and Minuteman IIIs. If Minuteman IIIs are chosen, the Soviets will expend two weapons for every silo, for a total of 1100 extra required weapons. This raises the percentage of Soviet weapons required for the surprise attack to 21.3% (1419/6655), which is quite an improvement from 4.8%. These 1419 weapons will destroy 5058 weapons (58.4% of the U.S. force) improving the exchange ratio (Soviet weapons to U.S. weapons) to about 3.6:1. This is the greatest improvement that can be made. Other targeting strategies have a maximum of about only 500 residual warheads or SWS available in 1990, which would give some improvement.

The change in Soviet second-strike capability showed a completely different pattern, with Soviet second-strike total EMT dropping in 1990 and rising in 1995. Figure 5.4 shows that targeting strategy rather than arms control proposals was the determining factor in Soviet EMT.

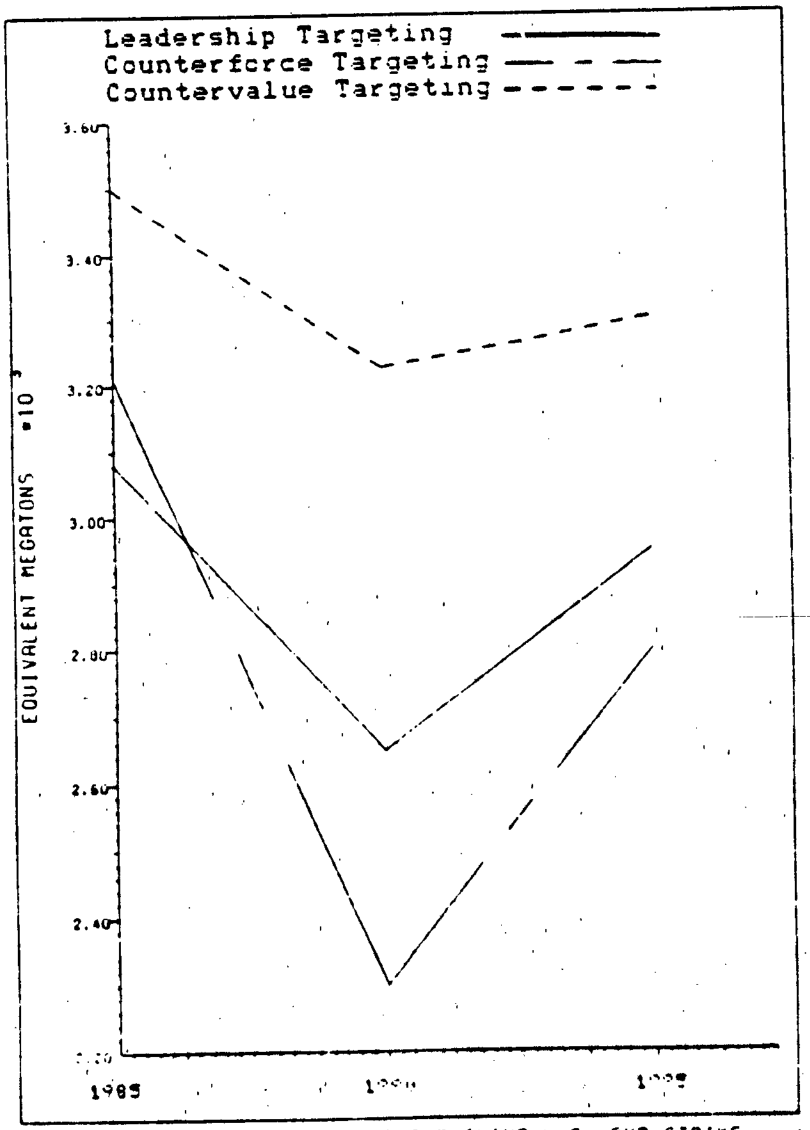

FIGURE 5.4: SOVIET EMT SURVIVING U.S. 2ND STRIKE

ANALYSIS OF DIFFERENCES

While there are many factors to account for the differences between the forces developed, this section will cover three major factors: differences in target bases, the differing requirements of the arms control proposals, and the problem of very hard targets.

Differences in Target Base

Even though each U.S. strike picked from the same target set, the differing DE goals for each individual target class under the three targeting strategies gave each strike a different complexion.

One difference was overall target hardness. A very rough approximation of overall target hardness could be obtained by averaging the Vulnerability Number (VN) of the targets required to meet DE goals. The VN is the first two numbers of the VNTK hardness given in the target base and roughly corresponds to an static or dynamic overpressure hardness. While this calculation ignores the other two factors of the VNTK number, it can be used as a "zero order" approximation. The results were as expected. Counterforce targets had an average VN of 19.7, countervalue targets had an average of 17.5, and leadership targets had an average of 18.4.

Another difference was in the number of required targets. There were 4698 counterforce targets, 4580 countervalue targets, and 4094 leadership targets. Taking the number of targets and the average VN together, it can be seen that the

counterforce targets would be the most difficult to cover, being both the hardest and largest set. Countervalue targets are more numerous while leadership targets are harder, so there is no clear choice of which presents a greater challenge to the attacking force. However, the harder leadership targets will tend to hurt a force lacking good hard target kill capability, such as the 1985 force. For example, the force which achieved 1.0 total DE for countervalue targets in 1985 could only achieve 0.53 DE on leadership targets. Once adequate hard-target weapons were added in 1990, leaderhsip targets required fewer weapons than countervalue targets. (8073 SWS versus 9188)

These differences among target bases are reflected in the capability of the forces. For example, the counterforce force, which had the most difficult target set, could only meet its DE goals in one case. By comparison, the countervalue force was able to meet its DE goals in every year under both arms control proposals.

Also, the softer countervalue targets favored the use of older, less accurate SLBMs over ICBMs. Since the relative softness of the targets did not require the accuracy of ICBMs, SLBMs were favored since they have a higher PA than ICBMs. Figures 5.5a, 5.5b and 5.5c show that the countervalue force had the most SLBM weapons and the fewest ICBMs. In fact, in 1995 the allocation would not have included any ICBMs unless they were forced into the problem.

FIGURE 5.5: RELATIVE NUMBER OF WHDS PER TRIPOD LEG

START ————
Kent - - - - - -
Note: A single line indicates that both plans gave the same results

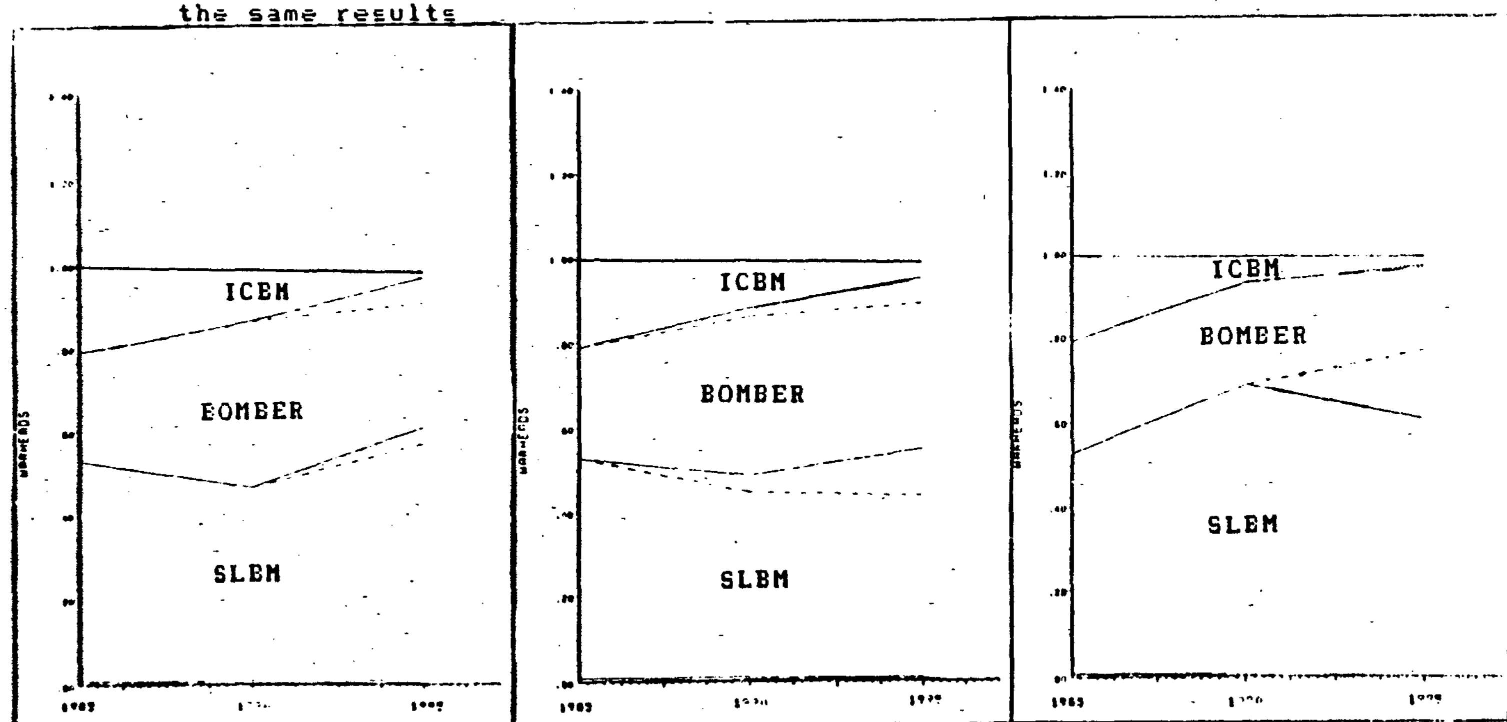

FIGURE 5.5B: COUNTERFORCE TARGETING

Differences in Proposals

Another reason for differences between forces was the actual arms control proposals. It is clear that General Kent's proposal is more restrictive in the numbers of weapons allowed for the total force than the START proposal. This is because START does not limit bombers and only limits cruise missiles to a maximum of 3500. General Kent's proposal limits all weapons. For ICBMs and SLBMs, there was little difference between warheads and SWS, since one warhead equals one SWS for most U.S. missiles. However, ALCM weapons are especially penalized under Kent, because each SWS equals only 0.6 ALCM weapons. (12 weapons/20 SWS) Therefore, in cases where the limit on RVs is reached, as many bombers or ALCM carriers as necessary can still remain in the force under START while ALCM carriers are at a disadvantage under Kent.

This preference for air-breathing weapons under START is demonstrated in almost every case. For example, in the 1995 countervalue forces (Table 5.9), the only difference between the two forces is that the 120 Trident C-4 missiles with 960 excess SWSs in Kent's proposal are traded for bomber weapons under START. In each case, capability is the same. Similar trades occur elsewhere. In all cases, the number of air-breathing weapons under START is equal to or greater than the number of air-breathing weapons under Kent. See Table 5.10 for a breakdown of U.S. forces by triad leg.

TABLE 5.10

U.S. WARHEADS BY TRIAD LEG

YEAR	SLBM	ICBM	BOMBER/ALCM
1985	5344	2137	2624
1990			
Leadership	5304	890	2808
Counterforce			
START	4104	1000	3204
Kent	3512	1000	3204
Countervalue	5234	510	1824
1995			
Leadership			
START	4096	226	2236
Kent	3704	589	2236
Counterforce			
START	4104	378	2976
Kent	2784	676	2820
Countervalue			
START	4280	200	2492
Kent	5240	200	1368

The more restrictive nature of Kent's proposal is manifested in several places. For example, the 1990 counterforce forces required many air-breathing weapons to meet hard-target DE goals. Because these weapons were not counted under START, a very large number of SLBMs could be used to cover the softer, lower priority targets and still remain within the arms control limits. However, since air-breath-

ing ALCMs are heavily penalized under Kent, a smaller number of SLBMs, as shown in the previous table, could be used. This resulted in a force which was unable to meet DE goals.

The Problem of Very Hard Targets

A third difference was caused by the number of very hard targets in a set. A large number of very hard targets creates a "sink" which requires a very large number of warheads. This is expecially true for the 1985 force, which had limited hard-target kill capability. For example, the 1985 counterforce set required the destruction of 80% of all ICBM silos, Launch Control Centers (LCC) and C^3I sites, for a total of 1320 hard targets. Of these, 800 were ICBMs which are very hard targets. The 1985 force was able to meet the 80% goal for LCCs and C^3I targets, but could only destroy 590 ICBM silos. The large number of weapons required caused only enough weapons to be left to destroy minimum levels of all lower priority targets.

Contrast this with countervalue targeting strategy used in 1985. In this strategy, only 50% of ICBMs and LCCs had to be destroyed. This reduced hard-target requirement allowed all targeting goals to be met with weapons to spare. The only 1985 weapons with good hard-target kill capability are Minuteman III (with the Mk-12A warhead) and ALCMs. Once these were used up, the hard-target kill capability for the remaining weapons was extremely poor. With the 1985 force, only about 500 ICBM targets can be covered by ALCMs and

Minuteman IIIs. Once the minimum DE requirements in all other classes were met, the remaining weapons could only destroy about 100 additional ICBM silos.

The 1990 force did not have the hard-target kill problems of the 1985 force. This is for two reasons. First, the introduction of the D-5 SLBM, Peacekeeper ICBM, and the B-1B brought new, highly capable weapons into the inventory. Also, additional ALCMs were available. These weapons increased the number of hard-target capable warheads. The second reason was a reduction in the number of hard targets which greatly the need for more capable weapons. Due to the arms control agreement, Soviet ICBM targets were reduced from 1000 in 1985 to 500 in 1995. This cut was the major reason for the large number of reserve weapons available in 1990. For example, an additional 685 RVs were available to the 1990 counterforce force under START. If the number of ICBM targets was 1000 instead of 500, an additional 400 ICBMs would have to be covered (using 80% as the desired DE), which would require approximately 800 RVs. Thus, even with increased capability, counterforce goals could not be achieved if the number of hard targets had not decreased.

A similar situation was created by the introduction of Mobile ICBMs (MICBM). It was assumed that only bombers were allowed to attack MICBMs, and even then had only a 0.3 or 0.4 Single Shot Probability of Kill (SSPK) because of the difficultiy in locating these MICBMs. This low SSPK

required weapon to target ratios of 3:1 and up to achieve the desired DE. With only 150 MICBMs in 1990, this was well within the capability of the B-1B force. However, with the growth of MICBMs to 500 in 1995, the entire B-1B and ATB force was only able to enforce a maximum of 0.75 DE on MICBMs. Thus the MICBMs became "sinks" for bomber weapons. The same situation occured for the Soviets attacking the SICBM. However, since they were using area bombardment with ballistic missiles, the weapon to target ratios were in excess of 50:1.

ASSESSMENT OF RESULTS

The arms control agreement favored by a decision maker will depend on the targeting strategy used by the U.S. Although no agreement dominated over all targeting strategies, very few differences in force structure or capability were observed between the agreements.

In the area of crisis stability measures, very little difference was observed between agreements or even among strategies. All "exchange ratio" calculations of Soviet weapons used versus U.S. weapons destroyed started at around 1:2 in the Soviets' favor, growing to more than 1:10 by 1990, and reversing to around 1.7:1 in the U.S. favor by 1995 (See Figure 5.3c). If the percentage of U.S. weapons surviving a surprise attack is used, the START proposal under counterforce targeting had approximately 10% more surviving weapons in 1995 (Figure 5.3b). All other

proposals showed an equal percentage of surviving weapons. Therefore, no arms control proposal dominated the crisis stability measures although the START proposal had a slight edge if counterforce targeting is used.

In the area of strategic stability, there was also no clearly superior arms control proposal. There was no difference at all between proposals in the amount of Soviet EMT remaining after the U.S. attack. If either leadership or countervalue targeting was used, there was no difference in the percentage of DE covered. However, if counterforce targeting is used, the START proposal clearly has a more capable force. This is because of the less restrictive nature of the START proposal. Of course, it could be argued that since one possible aim of arms control is to control counterforce capability, one would want to pick Kent's proposal. However, it is assumed that a decision maker would prefer to maximize U.S. capability.

Finally, in the measure of U.S. war-fighting capability, only the potential number of residual weapons remains to be covered. Again, no single agreement dominated. Figures 5.2a and 5.2b indicate that for leadership targeting, both proposals had over 1500 possible residual weapons or SWS in 1990, decreasing to nearly zero in 1995. Counterforce targeting favored the START proposal, since some residual RVs could be added to the 1990 force. The force under Kent's proposal had no possible residual weapons in any year.

Conversely, countervalue targeting seemed to favor the Kent proposal. The number of residual RVs under START was always less than 100. However, under Kent's proposal more than 500 SWS would be allowed in 1990 and 250 in 1995. However, it should be noted that because START does not count air-breathing weapons, an additional 105 ALCM (up from 52 required) carriers could be maintained in 1990 (1260 weapons), and all 157 ALCM carriers could be kept until 1995 for a total of 1884 extra weapons. Again, START allows for more residual weapons. Figure 5.6 shows the residual warheads available under START if air-breathing warheads are included.

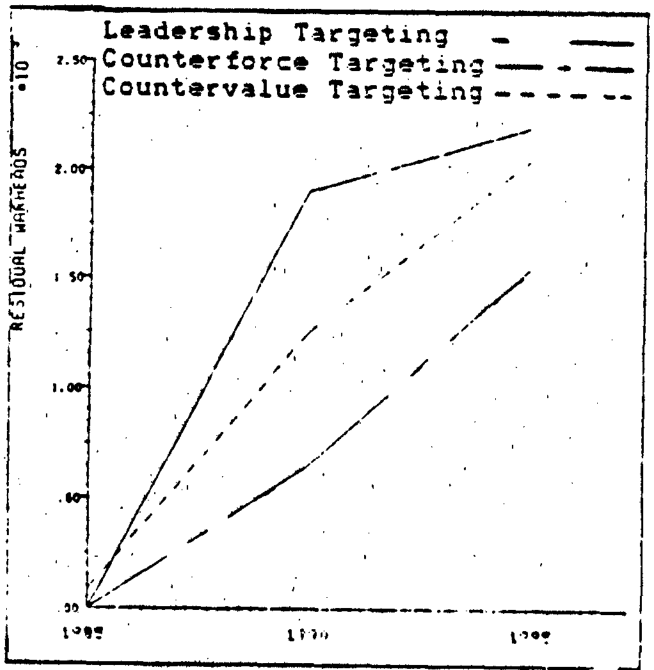

FIGURE 5.6: START RESIDUAL WHDS INCLUDING BOMBERS

The Bottom Line

If counterforce targeting is used, the administration START proposal would be favored. The START proposal allows a more capable force both in DE accomplishment and in number of residual weapons. Additionally, the START proposal resulted in a slightly more survivable force in 1995. These factors make it clearly superior to General Kent's proposal.

For countervalue targeting, a slight edge must be given to START. While no difference was observed in the areas of DE accomplishment or stability, the START proposal allowed for more residual weapons, since it does not effectively limit bomber or ALCM weapons. If these weapons were discounted, Kent's proposal provides for a higher number of residual weapons.

Leadership targeting showed a similar trend. Force stability and DE accomplishment were effectively the same. If air-breathing weapons not counted in START are discounted, the number of residual weapons are approximately the same. However, as in the case of countervalue targeting, extra ALCM and B-1B weapons could be kept in 1990 and 1995 which would swing the residual calculations in favor of START.

Other factors than these measures could play a larger part in the decision. For example, keeping a fleet of 157 B-52 ALCM carriers active through 1995, as would be possible

under START, could prove to be prohibitably expensive. However, it must be pointed out that the current plan seems to be to do just that.

Another possible factor would be the number of SICBMs deployed. The 1995 Soviet force is capable of destroying about 60 SICBMs in a barrage attack. As the number of SICBMs drops from around 700 under Kent's proposal to 200 under START, these 60 weapons destroyed take on a larger role. However, the benefits of having 500 more surviving weapons (which is a small portion of the total force) must be weighed against the costs of finding space to deploy these weapons. People who are enamored with the SICBM should remember the MX basing controversy.

OBSERVATIONS

While the purpose of this thesis is to develop a methodology for analyzing an arms control problem using unclassified and unofficial sources, some observations may be made for the "real world" problem. The major assumption for this section is that the data and results have come close to the actual situation. It is not meant that this analysis has given actual U.S. capabilities, but based on the results, the following observations may be made:

1) Arms control does not limit U.S. capabilities. Neither of the possible agreements prevented newer, more capable weapons from coming on line. The older, less capable weapons were retired earlier, which gave an overall

force with increasing capability. If the same type of reductions were carried on beyond 1995, capability would only then begin to decline.

2) Counterforce targeting is not a good idea -- yet. The lack of really effective hard-target weapons in the present force severely limits U.S. capability. Attempts to use other, less capable weapons only serve to "waste" those weapons when they could be better used on softer targets. Two things have to happen to make counterforce a good idea, more hard-target weapons for the U.S. and less Soviet hard targets.

3) An emphasis on countervalue targeting works well in maximizing the number of Soviet targets killed, but also maximizes the Soviet restrike. This type of targeting is relatively easy, but is done at the cost of allowing more Soviet weapons to survive. Soviet EMT available ranged from 3500 to 3200. Figure 5.4 shows that Soviet second-strike EMT was 20% to 30% lower if either leadership or counter-force targeting strategies are used.

4) Silo-based ICBMs undermine crisis stability, especially if there are only a few of them. Once ICBM/SLBM CEPs get down to about 100 meters, it does not really matter how hard the silo is. Unless the silos are in some type of deep underground basing mode, it is likely that even the hardest silos would be destroyed. Even if the silo survives the detonation, ICBMs do not work well when the silo is

lying on its side in the bottom of the crater! This means that in the future, any fixed ICBM can be destroyed with a high probability if two weapons are used against it. If the U.S. chooses to greatly reduce the number of ICBM targets, the Soviets will be able to destroy many more weapons than they use in a surprise attack on U.S. forces. It takes only about 100 weapons to target non-alert bombers and submarines in port with a high probability of kill. If there are only 100 ICBM targets, the Soviets then only require 300 warheads to destroy one-half of the U.S. forces. Such a favorable ratio could tempt a first strike, especially if the U.S. was perceived to lack the capability or will to respond.

5) Mobile ICBMs increase stability. If a barrage attack is used against MICBMs, weapon-to-target ratios required to destroy the MICBMs are in excess of 50:1. Even if bombers are used (which would not be a very effective surprise attack), weapon-to-target ratios are still 3:1 or greater. A large force of mobile ICBMs would require the weight of the entire Soviet ballistic missile force to produce even marginal results. Using the methodology in this thesis, over 4000 warheads were used to kill just about 60 MICBMs. This was the main reason for the switch in the Soviet gain versus Soviet loss calculations for the 1995 forces.

6) There is a continued requirement for the penetrating bomber. Until the capability exists to quickly locate, target, and destroy Strategically Relocatable Targets (SRT),

using satellite reconnaissance and ballistic missiles, the only way of effectively attacking SRTs is with a penetrating bomber. If the numbers of these targets continues to grow, the U.S. must be able to continue to effectively deal with them. Note that the 1995 bomber force was capable of only destroying about 375 MICBMs. Additionally, the lack of sufficient numbers of bombers in the day-to-day alert posture kept the DE goal for MICBMs from being met even though ICBMs and SLBMs were unused. As more are deployed, either more bombers would be required, or a decrease in capability accepted.

SUMMARY

This chapter covered the final phases of the analysis, which were the presentation of results and the scoring of the alternatives according to the established criteria. First, the differing forces were developed from the 1985 baseline to 1995. Next measurements of both U.S. and Soviet forces in the areas of stability and capability were presented. Finally, the differences in the forces were discussed, centering around the three factors of the differing target bases, arms control proposals, and the problems of very hard targets.

With these measures of merit, it was shown that the administration's START proposal had a slight edge under countervalue and leadership targeting strategies, and was

clearly superior if a counterforce strategy was used. The major difference seemed to be that the START proposal did not limit air-breathing weapons (except for the 3500 ALCM limit which had no effect), and therefore allowed as many of these as could be built. This led to much higher possible residual forces under START. It was pointed out that these residuals were the only difference in both countervalue and leadership targeting forces, and that other factors, such as cost or political factors may carry more weight in those two cases.

Lastly, some observations for the "real world" were made. It was noted that arms control will not limit destructive capability, at least in the near term. Some pitfalls of both counterforce and countervalue targeting were noted. The destabilizing impact of fixed ICBMs and the stabilizing factor of mobile ICBMs were contrasted. Finally, the continuing role of the penetrating bomber as the only system capable of destroying SRTs was noted.

The final chapter will present the conclusions and recommendations of this study.

CHAPTER SIX: CONCLUSIONS AND AREAS FOR FURTHER STUDY

This chapter summarizes the development of the methodology, evolution of forces and capabilities, and implications of the analysis. Additionally, areas for further study are presented.

SUMMARY

The purpose of this thesis was to develop a methodology to help an analyst evaluate arms control proposals. The methodology followed a modified systems analysis paradigm.

First, the objectives, both of arms control and of nuclear forces in general were developed. It was shown that while three different goals of arms control are stability, reduction of destructive capability, and cost savings, only stability was germane to the problem in the near term. Stability was shown to have three parts, crisis, strategic, and arms race stability. Only crisis and strategic stability were addressed in this analysis.

Next, the role of nuclear forces in national security objectives was discussed. The objectives of nuclear forces in maintaining national security are deterrence and warfighting if deterrence fails. The four parts of deterrence, knowledge of what the enemy values, capability to destroy those valuable assets, will to use capabilities, and enemy perception of the first three, were discussed and it was shown that capability is the primary measure of deterrence.

Once the objectives were developed and reduced to the sub-objectives of stability and capability, measures of merit were developed for these objectives. The crisis stability measure of effectiveness was an exchange ratio between number of U.S. weapons destroyed and the number of Soviet weapons used in a surprise attack. Since strategic stability rests upon second strike capability, the measures used in this area were the percentage of required Damage Expectancy (DE) accomplished and the Soviet EMT surviving the U.S. attack. Force capability was also measured using DE and the number of residual weapons available.

Two alternative strategies, the "build-down" plan proposed by the administration (START) and a five-percent annual reduction in the number of Standard Weapons Stations (SWS) proposed by General Glenn Kent, were developed, and some of their pros and cons discussed.

Three methods of implementing deterrence -- leadership targeting, counterforce targeting, and countervalue targeting -- were then developed. Since the actual U.S. targeting strategy is not known, using a cross-section of strategies would show the ability of each proposal across a spectrum of possible strategies.

Next, the methodology for using the BRIK goal-programming nuclear exchange model to both determine and generate

measures of merit for force structures under the two proposals was developed. The assumed scenario and U.S. and Soviet weapon and target bases were explained in detail.

Once the assumptions were covered, the actual procedure for using the model was shown. First, capabilities for the 1985 forces on both the U.S. and Soviet sides were calculated. Next, the Soviet target and weapon base was updated for the 1990 force. New U.S. weapon candidates were added to the U.S. weapon base, and BRIK was called upon to perform an allocation using these candidate weapons with a constraint added for the maximum number of weapons allowed by the arms control agreement. After this allocation was performed, the force was checked to insure that all required build-down goals were met, and that all developed forces still maintained the triad of nuclear forces. Finally, surviving Soviet EMT was calculated by hand using the DE results from BRIK.

Once the 1990 U.S. forces were developed, a "surprise attack" counterforce strike was made by the Soviet forces. The measures of crisis stability were generated in this exchange.

Once the 1990 forces were developed, the same procedure was followed for 1995. Once all figures had been calculated, the various charts showing U.S. and Soviet measures of merit were developed.

After the methodology was developed, the BRIK model was briefly reviewed. Any similar goal-programming model could be used for this analysis, but BRIK's speed, flexibility, and ease of use made it a powerful tool. Since BRIK has only recently been developed, some changes were required in the model. Several new features, such as the ability to directly input Single Shot Probabilities of Kill (SSPK), a batch run capability and an updated SSPK function for targets over 1000 psi hardness were added. Also, several minor errors in the original model were noted and corrected. Finally, changes were made to enhance the model portability, so that BRIK may be used on other computers than the VAX.

Once the model was reviewed and upgraded, the results of the analysis and their assesment were presented. The evolution of U.S. forces under each arms control proposal and all targeting strategies was shown. It was noted that in many cases, the two proposals produced very similar forces.

The capabilities of U.S. and Soviet forces were examined, and the observation made that in the area of DE accomplishment, only the counterforce strategy produced any difference in force capability between the two arms control plans. The administration START proposal produced a more capable force if the counterforce strategy was used. In the area of residual weapons, it was noted that START allowed more residual weapons in all cases, since air-breathing weapons had no effective limit.

In the area of crisis stability, little difference was noted in any of the forces. In all cases, the exchange ratio of Soviet weapons used per U.S. weapons destroyed went from 1:2 in the Soviets' favor in 1985 to greater than 1:10 in 1990, then reversing in the U.S. favor to about 1.7:1 in 1995. It was noted that the continued deployment of land-based Minuteman ICBMs, which would be permitted in some cases, could significantly improve the 1990 exchange ratio from 1:10 to approximately 1:3.6.

Three major reasons were noted for the difference in U.S. forces and capabilities, these were differences in the target base, differing requirements of the arms control proposals, and the problem of very hard targets.

The counterforce target base was shown to be the most difficult, having the largest number of targets and the highest average hardness. While the difference between the countervalue and leadership target sets was not as clear, it was noted that the fact that the countervalue targets had the lowest average hardness allowed forces without good hard-target kill capability to do well against it.

The less restrictive nature of the START proposal worked in its favor, since air-breathing weapons could be maintained without penalty. Differences between the forces were often a matter of trading bomber weapons for ballistic

missile warheads. In particular, the START proposal allowed a much greater residual weapon capability, since large numbers of ALCM carriers could be kept.

Finally, the problem of very hard targets was discussed. When hard-target kill capability is lacking, these targets soak up more than their share of weapons. If these have high priority, then almost all of the weapons will be expended in a fruitless quest to destroy these targets. The weapons used to destroy an extra 200-300 hard targets could destroy over 1000 softer targets. This proved to be a major problem in the 1985 force. It was also noted that the reduction in the number of Soviet ICBM targets from 1000 to 500 in 1990 played a major role in the increase in U.S. percentage capability.

The bottom line of these results is that the arms control proposal favored by a decision maker may depend on the targeting strategy used. If a counterforce strategy is used, the START proposal is to be favored, as it gives greater DE accomplishment, residual weapon capability, and force survivability. If either leadership or countervalue targeting is used, the START proposal still has an edge, but only in the area of possible residual forces. It may be that other economic and political factors will carry more weight in the decision, since both proposals offer equal DE accomplishment levels and equal crisis stability measures.

Some observations about the real world problem were then made, which should be taken with several grains of salt, since this is actually a methodology development effort rather than an actual force assessment.

First, it was shown that destructive capability is not reduced by arms control. In fact, DE capability rises. If the arms control agreements are extended past 1995, some reduction in destructive capability is possible. Next, it was noted that counterforce targeting is not a very good idea until both U.S. capability increases and the number of Soviet force targets decrease. The major pitfall of countervalue targeting, that it maximizes Soviet restrike capability, was then discussed. The negative contribution to stability of fixed land-based ICBMs and the positive contribution of mobile ICBMs were discussed. Finally, it was noted that as long as the U.S. lacks a quick and effective capability to locate and destroy Strategically Relocatable Targets using ballistic missiles, the penetrating bomber will continue to be a necessary part of the force.

This completes the summary of the analysis. The next section will cover some future directions for study.

AREAS FOR FUTURE STUDY

It would be nice to say that this thesis is the answer to life, the universe, and everything. However, it is a long way from that. In this writer's opinion, there are three possible avenues for future work. They are unresolved

problems in BRIK, sensitivity analysis, and attempting to use this methodology to support an actual decision.

Problems with BRIK

Two potential problem areas with BRIK were identified by its authors. They are the lack of capability for BRIK to maximize DE and the optimistic damage function. (2:105-106) Both of these problems remain.

The problem of not being able to maximize DE rises from an approximation used in BRIK. Letting d_j be a variable representing distance from the required damage goal, which is the desired number of targets killed in class j, and N_j be the number of targets in class j, then as d_j/N_j gets closer to zero,

$$(e^{(d_j/N_j)}-1) \sim d_j/N_j$$

This approximation was necessary because the original term is non-linear, and an objective function which sought to minimize this deviation would not be linear -- and this would be unsolvable using the linear programming algorithm used in BRIK. Unfortunately, d_j/N_j is only an accurate approximation when the actual deviation from the goal is small. (2:62) In reality, as more weapons are allocated to a target class, the marginal increase in damage expectancy decreases. However, due to the above approximation, BRIK uses a constant rate of return regardless of the number of weapons allocated to a class. As the difference from a goal becomes large, the deviation from the goal approximation

used by BRIK will not accurately reflect the actual deviation. As long as goals are nearly or exactly met, the allocation is close to optimal. However, to maximize DE, one must maximize the deviations above goals. These potentially large deviations make the approximation used in BRIK invalid.

Two solutions suggest themselves. The first, as suggested by the authors, would be to iteratively change goals until DE is maximized. Two things are not clear, the first is the stopping rule. Unless it is already known what the maximum DE is, how does an analyst know when to stop. Secondly, it would prove very tedious to do this interactively, especially if there were a large number of different goals. Some type of numerical search technique could be used and implemented as a computer algorithm, but it is not known whether or not such a search would provide an "optimal" solution.

A more promising approach may be the use of a post processor. This program could take output from BRIK and apply a Lagrangian technique to further maximize the DE. BRIK could make the original allocation to meet a set of minimum goals, then the post-processor would maximize DE once the minimum goals were met by maximizing the sum of deviations above the goals which would be in their original

exponential form. While this may not give a true maximization because of the minimum goals, it would add greatly to BRIK's capability.

Additionally, this potentially invalid approximation will cause problems if the allocation does not meet the goals, especially if high priority goals are not met. Future users of BRIK must either correct the approximation problem or be very careful that goals and capabilities are well matched. Failure to match goals and capabilities will result in much than optimal allocations.

The other problem is the "optimistic" DE function. This arises from the use of a damage function approximation which allows the use of non-integer weapon to target allocation. This is used in two places in the model. First, it is used in the section which builds target and hedging constraints. Secondly, the function is used in the output section to compute DE achievement. (2:106-108) In small allocations, this causes such things as 4.08 weapons destroying 5 targets. Internal corrections to the model would be difficult and require complete restructuring of the model. It is possible to recalculate achievement using the assumption the 4.08 targets each received one weapon. (2:109) However, it is not certain that it is better to use fractional targets than fractional weapons. The magnitude of this error is "believed to be small". (2:43) Future work in this area should start with determining the actual magnitude of this

problem using a number of different allocations. It is possible to correct the DE of the model using whatever damage function an analyst wishes, either by hand calculations or a special post-processor for BRIK's output. This may give BRIK greater flexibility to use other damage functions, but the new damage function may be inconsistent with the function used by BRIK to make the allocation.

One problem that cropped up during the analysis was that excessive use of Type One hedges (enforcing a minimum level of DE on a target class) in some cases made the program "blow up," causing the computer to run endlessly and producing no allocation. This occurred only in large problems where the minimum DE required for the hedge could be met, but the maximum DE goal could not be achieved. Additionally, the problem only occurred when Type One hedges were used for all target classes. The cause of this problem is still unidentified. However, some investigation suggests a problem in the PAGP algorithm which solves the optimization, perhaps in a stopping rule that was not implemented. Other flaws have been noted with PAGP, especially with large problems. (4)

One final area for changes in the model is in user friendliness. While the menu-driven format used by the authors is fine for small problems or new users, the time required to wade through all the menus soon became quite tedious. While a rather primitive batch mode was added for

this analysis, consisting of creating an input file containing all the interactive commands for a run, a better solution would be to create an expert-user mode, which would streamline the process by reducing or eliminating menus and allow input files to be used for such things as hedges.

This completes the section on proposed model changes. Next, three possible areas for sensitivity analysis will be discussed.

Sensitivity Analysis

While some insight into the problem was gained by using several targeting strategies and both generated and day-to-day alert forces, more insight is needed on the sensitivity of the force allocations to changes in weapon characteristics, target characteristics, and goals.

Two weapon characteristics which should be more closely examined are probability of arrival (which BRIK refers to as reliability) and weapon CEP. For example, hard-target kill capability is heavily dependent on weapon CEP. While it was attempted to get the best possible CEP estimates, these estimates can vary by at least 100 meters. Future analysis should account for the effects of varying CEP.

Probability of arrival (PA) is made up of three different factors, pre-launch survivability, weapon system reliability, and probability to penetrate enemy defenses. Since all

three are estimates, the possible error on the PA figure may be fairly large. As in the case of CEP, the sensitivity of the analysis to differences in PA should be investigated.

The major target characteristic which should be varied is the target hardness. It may be that the given target hardnesses are too high. If softer targets are used, the forces created could change markedly.

One additional area for sensitivity analysis is in the area of goals. If the magnitude or order of the goals are changed, the new solution may be more satisfactory in some sense than the previous "optimal" solution. For example, lowering the priority of ICBM silo targets could pay great dividends in the number of other targets destroyed. Being able to destroy 300 other targets may be preferable to destroying 100 ICBM silos.

While other factors are amenable to sensitivity analysis, these three areas of weapon characteristics, target characteristics and goals should be explored. The next section will cover the final area for additional work.

Solve the "Real" Problem

This may be the most difficult task of all. While it was difficult enough to analyze the situation when unavailable numbers could be assumed, it will undoubtedly be more difficult to use this methodology to support an actual decision. Such an effort could not be done on an unclassified level, as it would require actual U.S. arms control proposals,

targeting strategy, force capabilities, future weapons capabilities, Soviet target base, and estimated Soviet present and future forces and capability. All of these would probably be classified. Such an effort would be a major step which would completely validate both the BRIK model and this methodology as well as helping to make an important decision for the future U.S. deterrent force. However, it is important to realize that the model problems mentioned previously must be corrected before using the BRIK model to support actual decisions.

CONCLUSION

This thesis develops a methodology to support future U.S. decisions in the areas of nuclear force structure and arms control. While the model used to generate measures of effectiveness was the BRIK goal-programming nuclear exchange model, any model of similar capabilities could be used. This methodology provides both a framework for analyzing and implementing arms control decisions and insights into the dynamics of the U.S. nuclear force structure of the future.

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APPENDIX A: CHANGES TO BRIK

This section is for users interested in updating BRIK to version 2.0. Change locations are identified by subroutine and line number within the subroutine. If large blocks of statements are added, subsequent changes will be referred to by the new line numbers. That is, if a statement in the original line 90 is changed, and a block of ten lines was added previously, the change will be referenced at line 100.

Changes come in three categories, errors, new features, and portability changes. Error changes correct actual errors within the original program. These changes will be denoted by an "E" in the left margin. New features are the new capabilities added to the model. These changes are labeled with a "NF" in the margin. Portability changes will aid the user interested in running BRIK on other computers than the VAX. They are mostly changes to correct non-ANSI constructs within the model. These changes are denoted by a "P" in the margin. With these portability changes, the same program will run without modification on both the VAX and CYBER computers.

The format for this section will be, a listing of the old line, followed by the changes. Comments are added where the change is not self-explanatory.

In the main program:

P Line 5:
COMMON/AIJIN1/NWPNS,NTGTS,SPARSE(20,20),AIJ(61,401),ICOUNT
delete "AIJ(61,401),"
add new next line:
COMMON/AIJIN2/AIJ(61,522)
Comment: This change implements the combining of the AIJ and TE arrays (which appears later). This is a memory-saving move.

P Line 12:
CHARACTER WPNAME(20)*6,TGTNAM(20)*6,TGTCAT(20),YESWGT
NF delete all three (20), add INPNAM*6,OUTNAM*6
Comment: This clears up a non-ANSI usage and adds the input and output file name variables for the new batch use feature.

P After line 13:
TGTPSI(20)*4,T,VNTK*4,A,B,C,D
Add two lines
OPEN (6,FILE='OUTPUT')
OPEN (5,FILE='INPUT')
Comment: This explicitly defines the input and output channels, rather than relying on the default values.

NF After line 17:
WRITE(6,190)
Add the following lines

```
      WRITE(6,*)'DO YOU WANT TO RUN THE PROGRAM'
      WRITE(6,*)'    1)   INTERACTIVELY'
      WRITE(6,*)'    2)   USING USER DESIGNED FILES'
      READ(5,*)NINTER
      IF (NINTER .EQ. 2) THEN
         WRITE(6,*)'ENTER THE INPUT FILE NAME'
999      FORMAT (A6)
         READ(5,999)INPNAM
         WRITE(6,*)'WHAT IS THE OUTPUT FILE NAME'
         READ(5,999)OUTNAM
         CLOSE(6)
         CLOSE(5)
         OPEN(6,FILE=OUTNAM)
         OPEN(5,FILE=INPNAM)
         REWIND 6
         REWIND 5
      ENDIF
```

Comment: This implements the ability to use a batch mode for running BRIK. The input and output file names must be a maximum of six characters. The input file must contain all of the necessary commands for an interactive session, and the output file will contain everything that would normally be sent to the screen.

P Line 60:
WPNYLD,WPNDDA,WPNGA,SPARSE,RHS,AIJ,ISUB,ITYPE,WGHT
delete "AIJ,"
Comment: AIJ is now sent using its common block, a memory-saving measure.

NF After line 159:
```
50    CONTINUE
```
Add new lines
```
      WRITE(6,*)'YOU MAY MANUALLY INPUT SINGLE SHOT
      PROBABILITIES'
      WRITE(6,*)'OF KILL FOR VARIOUS WEAPON/TARGET
      COMBINATIONS.'
      WRITE(6,*)'THIS FEATURE IS FOR ADVANCED USERS WHO'
      WRITE(6,*)'WISH TO OVERRIDE BRIK''S SSPK FUNCTIONS.'
51    WRITE(6,*)'INPUT WEAPON NUMBER, TGT NUMBER AND SSPK'
      WRITE(6,*)'AN ENTRY OF 0,1,1 WILL EXIT THIS SECTION'
      READ(5,*)J,I,TPK
      IF (J .EQ. 0) GOTO 52
            SPARSE(I,J)=1-WPNREL(J)*TPK
            IF (SPARSE(I,J).LT..001) SPARSE(I,J)=.001
            IF (SPARSE(I,J).GT.1.0) SPARSE(I,J)=1.0
            GOTO 51
```
Line 159: (The next line)
```
      CLOSE(15)
```
add a label: 52

In suroutine ZEROIZE:

P Line 7:
RHS,AIJ,ISUB,ITYPE,WGHT,NTOF,IPRIN,WPNAME,TGTNAME)
delete "AIJ,"
Add new next line:
COMMON/AIJIN2/AIJ(61,522)

P Line 52:
DO 50 J=1,401
change 401 to 522
Comment: reflects increased size of AIJ array if it is combined with the TE array to save space.

In subroutine TGTINS:

P Line 27:
WRITE(6,*)'HIT RETURN TO CONTINUE'
change message to:
'ENTER ANY CHARACTER TO CONTINUE'
Comment: Some machines will not accept just a carriage return if they are expecting a variable. This will work on any machine.

In subroutine WPNINS:

```
P  Line 27:
   WRITE(6,*)'HIT RETURN TO CONTINUE'
   change message to
   'ENTER ANY CHARACTER TO CONTINUE'
```

In subroutine TGTINF:

```
P  Line 18:
   FORMAT(A6,X,I4,X,A4,X,F5.2,3X,A1,4X,I1,2X,F5.2,X,
   change all single "X" to "1X"
   Comment:  "X" for a single space is non-ANSI
```

In suroutine WPNINF:

```
P  Line 8:
   FORMAT(A6,2X,I5,4X,I3,2X,F5.2,X,F5.3,X,F5.2,3X,F4.2,5X,
   change all single "X" to "1X"
```

In subroutine TGTFIL:

```
P  Line 11:
   FORMAT(A6,X,I4,X,A4,X,F5.2,3X,A1,4X,I1,2X,F5.2,X,F4.2,X
   change all single "X" to "1X"
```

In subroutine WPNFIL:

```
P  Line 11:
   FORMAT(A6,2X,I5,4X,I3,2X,F5.2,X,F5.3,X,F5.2,3X,F4.2,5X,
   change all single "X" to "1X"
```

In subroutine WEIGHT:

```
P  Line 13:
   FORMAT(X,I2,8X,A6,14X,F8.2)
   change single "X" to "1X"
```

In function PK:

```
NF After Line 19:
   RL=(6.81*YIELD**(2./3.))/PSI**.62
   the next four lines should be:
   ELSE IF (PSI.GT.10.0 .AND. PSI.LE.1000.0) THEN
         RL=2.8*YIELD**(1./3.)*((PSI-7.37)**(-.352)
   ELSE
         RL=2.62*YIELD**(1./3.)/(PSI**(1./3.))
   Comment:  This updates the PK function for targets harder
   than 1000 psi.
```

In subroutine DECHECK:

P Line 9:
```
FORMAT(X,I2,7X,A6,9X,A1,6X,F6.2)
```
change "X" to "1X"

P Line 64:
```
40    FORMAT(/////////////////)
```
The RETURN on the next line should be deleted
Comment: This RETURN statement cannot be reached from any point in the program (dead code).

In subroutine PARCH2:

E Line 6:
```
CHARACTER TGTCAT(25)
```
change 25 to 20

In subroutine OBJECT:

P Line 7:
```
COMMON/AIJIN1/NWPNS,NTGTS,SPARSE(20,20),AIJ(61,401),ICOUNT
```
delete "AIJ(61,401),"
add next line:
```
COMMON/AIJIN2/AIJ(61,522)
```

P Line 12:
```
CHARACTER TGTCAT(20),YES
```
delete "(20)"
Comment: Non-Ansi construct.

In subroutine WTINTR:

P Line 5:
```
COMMON/AIJIN1/NWPNS,.....
```
delete "AIJ(61,401),"
add next line
```
COMMON/AIJIN2/AIJ(61,522)
```

P Line 8:
```
CHARACTER WPNAME(20)*6,TGTNAM(20)*6,AB
```
delete both "(20)"s.
Comment: Non-Ansi.

P Line 16:
```
WRITE(6,*)'TIONS MADE.  (HIT RETURN TO CONTINUE)'
```
change message to
ENTER ANY CHARACTER TO CONTINUE'

In subroutine HEDGE:

```
P  Line 7:
   COMMON/AIJIN1/NWPNS,....
   delete "AIJ(61,401),"
   add next line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 11:
   CHARACTER WPNAME(20)*6,TGTNAM(20)*6,AB
   delete both "(20)"s
```

In subroutine AIJIN:

```
P  Line 5:
   COMMON/AIJIN1/NWPNS,....
   delete "AIJ(61,401),"
   add next line
   COMMON/AIJIN2/AIJ(61,522)
```

In subroutine FILEIN:

```
P  Line 8:
   COMMON/AIJIN1/NWPNS,....
   delete "AIJ(61,401),"
   add next line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 11:
   CHARACTER WPNAME(20)*6,TGTNAM(20)*6
   delete both "(20)"s
```

In subroutine CHANGE:

```
P  Line 6:
   DIMENSION NC(10),NCON(20,10),NTOF(10),AIJ(61,401),
   change AIJ dimension to (61,522)

P  Line 88:
   WRITE(6,*)'OF OPTIONS AVAILABLE. (HIT RETURN TO CONTINUE)
   change message to
   ENTER A CHARACTER TO CONTINUE'

E  Line 126:
   IF (NC(3) .NE. O .AND. NTOF(3).NE.NTGTS) THEN
   change "O" to "0"

P  Line 172:
   WRITE(6,*)'NOT AFFECT YOUR SOLUTION.  (HIT RETURN'
   change message to
   (ENTER ANY CHARACTER'
```

P Line 179:

```
WRITE(6,*)'FOR MORE EXPLANATION. (HIT RETURN TO CONTINUE)'
```

delete "(HIT RETURN TO CONTINUE)"
add new line

```
WRITE(6,*)'ENTER ANY CHARACTER TO CONTINUE'
```

E Line 263:

```
TPK=VTK(VN,T,IK,F95,WPNYLD(I),WPNCEP(I))
```

change "F95" to "R95"
Comment: This incorrect variable name would cause the VTK function to treat all targets as point targets, giving incorrect results for area targets.

E Line 396:

```
IF(NC(N).EQ.O) GOTO 1650
```

change "O" to "0"

In subroutine HEADER:

E Line 38:

```
DO 50, I=1,450000
```

change 450000 to 4500
Comment: This variable is larger than MAXINT (the Maximum integer value allowed) for just about any machine. Its only purpose is to give the user about 45 seconds to read the header -- a waste of time and resources.

E Line ~?:

```
I=I+1
```

delete this line
Comment: It is illegal to redefine the DO variable in a DO-LOOP.

In function VTK:

P Line 7:

```
INTEGER H
```

change to INTEGER H,T
Comment: T is used as an array subscript and should be an integer.

In subroutine BOUT:

P Line 6:

```
COMMON TT(10,522),TB(61),TE(61,522),TL(61,10),TA(10),
```

delete "TE(61,522),"

P Line 9:
```
COMMON/CHNG/NCON(61,10),NTOF(10)
```
add next line
```
COMMON/AIJIN2/AIJ(61,522)
```
Comment: The old "TE" array is overlayed on the "AIJ" array to save memory space. All subsequent references to TE will be changed to AIJ.

P Line 59:
```
C **** ZERO THE TE,TL,TT, AND TI ARRAYS.
```
change TE to AIJ

P Line 67:
```
102  TE(NR,NCR)=0.
```
change TE to AIJ

In subroutine PHSE1:

P Line 7:
```
COMMON TT(10,522),TB(61),TE(61,522),...
```
delete "TE(61,522),"

P Line 9:
```
COMMON/PHASE1/W,NRCON,NDVR
```
add next line
```
COMMON/AIJIN2/AIJ(61,522)
```

P Line 28:
```
READ (11,118) TB(NR),(TE(NR,NV),NV=1,NVAR)
```
change TE to AIJ

P Line 35:
```
104  TE(NR,NAR)=1.
```
change TE to AIJ

P Line 53:
```
108  CR(NV)=CR(NV)-CB(NR)*TE(NR,NV)
```
change TE to AIJ

P Line 77:
```
IF (TE(NR,NEVC).LE.0.) GO TO 111
```
change TE to AIJ in this and the next line (78)

P Line 97:
```
PIV=TE(NDVR,NEVC)
```
change TE to AIJ

P Line 101:
```
IF (ABS(TE(NR,NEVC).LE.0.0005) GO TO 113
```
change TE to AIJ in this and the next line (102)

```
P  Line 105:
   112  TE(NR,NV)=FIX(TE(NR,NV)-TE(NDVR,NV)*PIX)
   change TE to AIJ (3 times)

P  Line 109:
   114  TE(NDVR,NV)=FIX(TE(NDVR,NV)/PIV)
   change TE to AIJ (2 times)

P  Line 127:
   TE(NR,NV)=0.
   change TE to AIJ

In subroutine READ1:

P  Line 7:
   COMMON TT(10,522),TB(61),TE(61,522),...
   delete "TE(61,522),"

P  Line 9:
   COMMON/CHNG/NCON(61,10),NTOF(10)
   add new line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 37:
   READ (11,*) TE(NCR,NV)
   change TE to AIJ

P  Line 42:
   AIJ(NCR,NV1)=1.
   change TE to AIJ in this and the next line (42)

In subroutine READ2:

P  Line 9:
   COMMON TT(10,522),TB(61),TE(61,522),....
   delete "TE(61,522),"

P  Line 11:
   COMMON/CHNG/NCON(61,10),NTOF(10)
   add new line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 29:
   READ(11,*) TE(NR,NV)
   change TE to AIJ

P  Line 31:
   TE(NR,NC1)=1.
   change TE to AIJ in this and the next line (32)
```

```
P  Line 39:
   TB(NR)=TB(NR)-TE(NR,J)*TB(NRC)
   change TE to AIJ

P  Line 42:
   TE(NR,NCR)=TE(NR,NCR)-TE(NR,J)*TE(NRC,NCR)
   change TE to AIJ (4 times)

P  Line 44:
   TE(NR,J)=0.
   change TE to AIJ

P  Line 55:
   104  TE(NR,NCR)=-TE(NR,NCR)
   change TE to AIJ (2 times)
```

In subroutine PLACE:

```
P  Line 15:
   COMMON TT(10,522),TB(61),TE(61,522),...
   delete "TE(61,522),"
```

In subroutine CINDX:

```
P  Line 8:
   COMMON TT(10,522),TB(61),TE(61,522),...
   delete "TE(61,522),"

P  Line 9:
   1OL(522,2),NCOLI,NROWI,NPRIC,NC(10),JROW(61,2),NVAR,NPRIT
   add new line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 20:
   102  TI(NPRIC,NCR)=TI(NPRIC,NCR)-TE(NR,NCR)*TL(NR,NPRIC)
   change TE to AIJ
```

In subroutine TEST:

```
P  Line 8:
   C **** TE( . ,NEVC) ARE NONPOSITIVE.
   change TE to AIJ

P  Line 10:
   COMMON TT(10,522),TB(61),TE(61,522),....
   delete "TE(61,522),"

P  After line 11:
   add new line
   COMMON/AIJIN2/AIJ(61,522)
```

```
P  Line 35:
   IF (TE(NR,NEVC).LE.0.) GO TO 105
   change TE to AIJ

In subroutine PERM:

P  Line 6:
   COMMON TT(10,522),TB(61),TE(61,522),....
   delete "TE(61,522),"

P  After line 7:
   add new line
   COMMON/AIJIN2/AIJ(61,522)

P  Line 20:
   C **** COMPUTE NEW TE ARRAY.
   change TE to AIJ

P  Line 22:
   PIV=TE(NDVR,NEVC)
   change TE to AIJ

P  Line 26:
   IF (ABS(TE(NR,NEVC)).LE.0.0005) GO TO 103
   change TE to AIJ in this and the next line

P  LINE 30:
   102  TE(NR,NCR)=FIX(TE(NR,NCR)-TE(NDVR,NCR)*PIX)
   change TE to AIJ (3 times)

P  Line 34:
   104  TE(NDVR,NCR)=FIX(TE(NDVR,NCR)/PIV)
   change TE to AIJ (2 times)

In subroutine POUT:

P  Line 5:
   COMMON TT(10,522),TB(61),TE(61,522),....
   delete "TE(61,522),"

P  After line 6:
   add new lines
   COMMON/AIJIN2/AIJ(61,522)
   COMMON/WTINT/WPNAME(20),TGTNAM(20)

P  Line 10:
   CHARACTER TGTNAM(20)*6,WPNAME(20)*6
   delete both "(20)"s
```

E Line 22:
DO 101, I=1,212
change 212 to 522
Comment: The original number (which was left from the original copy of the PAGP algorithm used by the authors) did not fully initialize the output array, giving unpredictable results.

P Line 52:
READ (11,*) TE(NR,NV)
change TE to AIJ

P Line 56:
104 RLHS(NCI,NP)=RLHS(NCI,NP)*TE(NR,NV)*WOUT(NV,2)
change TE to AIJ

In subroutine PAGE:

P Line 13:
WRITE(6,*)'HIT RETURN TO CONTINUE'
change message to
'ENTER ANY CHARACTER TO CONTINUE'

APPENDIX B: COMPLETE DATA LISTING

This appendix contains the results from the ERIK runs used to both generate and evaluate nuclear forces for this study. The list is arranged chronologically. Within each year, the order is U.S. generated forces, U.S. day-to-day forces and Soviet forces. Each run result is labeled by year, targeting strategy, arms control proposal and alert status. When results were the same for both arms control proposals, this is also noted.

LEGEND:

TITAN	= TITAN	MMII	= MINUTEMAN II
MMIII1	= MINUTEMAN 3	MM1112	= MINUTEMAN 3 (MK-12A RV)
POSEID	= POSEIDON (C-3)	TRIDC4	= TRIDENT (C-4)
B52GRV	= B-52G (BOMBS)	B52SRM	= B-52 (SRAMS)
52HGRV	= B-52H (BOMBS)	52ALCM	= B-52 ALCM CARRIER
111SRM	= FB-111 (SRAMS)	FB111	= FB-111 (BOMBS)
B1BGRV	= B-1B (BOMBS)	B1BMC	= B-1B ALCM CARRIER
MX12A	= MX (MK-12A RV)	TRIDD5	= TRIDENT (D-5)
SICBM	= SMALL ICBM	ATB	= ADVANCED TECH. BOMBER

1985 LEADERSHIP TARGETING GENERATED ALERT
TOTAL VALUE DESTROYED WAS 2173.8.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	POSEID	417.60	.80	.80	28.0
LOCAL	POSEID	220.28	.80	.80	43.0
C3I	TRIDNT	1604.03	.80	.80	90.0
	B52GRV	227.80			
	B52SRM	235.43			
	52HGRV	306.00			
	111SRM	204.00			
ICBM	TITAN	36.26	.70	.61	393.7
	MMII	441.00			
	MMIII1	168.95			
	MMIII2	882.00			
	52ALCM	856.80			
	FB111	102.00			
LCC	MMIII1	566.05	.70	.70	60.0
	POSEID	1114.57			
	B52SRM	56.59			
NUKSTO	B52SRM	241.78	.70	.70	15.0
SUBPTS	POSEID	36.02	.70	.70	6.0
IRBM	POSEID	112.27	.70	.70	45.0
AFBASE	POSEID	14.23	.60	.20	80.0
STORES	TRIDNT	239.17	.60	.20	344.0
FACIL	POSEID	172.42	.60	20	416.0
FACTOR	POSEID	85.49	.50	.10	990.0
DEPOS	POSEID	109.05	.60	.20	440.0
NAVAL	POSEID	26.01	.60	.20	104.0
POL	POSEID	85.11	.50	.10	1170.0
ENERGY	POSEID	38.96	.50	.10	391.5

WPNAME	NUMBER	USED	REMAIN
TITAN	36.3	36.3	.0
MMII	441.0	441.0	.0
MMIII1	735.0	735.0	.0
MMIII2	882.0	882.0	.0
POSEID	2432.0	2432.0	.0
TRIDNT	1843.2	1843.2	.0
B52GRV	227.8	227.8	.0
B52SRM	533.8	533.8	.0
52HGRV	306.0	306.0	.0
52ALCM	856.3	856.8	.0
111SRM	204.0	204.0	.0
FB111	102.0	102.0	.0

1985 COUNTERFORCE STRATEGY: GENERATED ALERT

TOTAL VALUE DESTROYED WAS 2085.9.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	POSEID	57.90	.60	.20	112.0
LOCAL	POSEID	30.54	.60	.20	172.0
C3I	TITAN	36.26	.80	.80	90.0
	TRIDNT	1460.91			
	B52GRV	227.80			
	B52SRM	293.01			
	52HGRV	306.00			
	111SRM	204.00			
ICBM	MMII	441.00	.80	.59	408.6
	MMIII2	845.50			
	52ALCM	856.80			
	FB111	67.31			
LCC	MMIII1	735.00	.80	.80	40.0
	MMIII2	36.50			
	POSEID	1538.37			
NUKSTO	B52SRM	240.79	.80	.80	10.0
	FB111	34.69			
SUBPTS	POSEID	48.14	.80	.80	4.0
IRBM	POSEID	33.26	.70	.30	105.0
AFBASE	POSEID	22.75	.70	.30	70.0
STORES	TRIDNT	382.29	.70	.30	301.0
FACIL	POSEID	275.59	.70	.30	364.0
FACTOR	POSEID	85.49	.50	.10	990.0
DEPOS	POSEID	174.30	.70	.30	385.0
NAVAL	POSEID	41.58	.70	.30	91.0
POL	POSEID	85.11	.50	.10	1170.0
ENERGY	POSEID	38.96	.50	.10	391.5

WPNAME	NUMBER	USED	REMAIN
TITAN	36.3	36.3	.0
MMII	441.0	441.0	.0
MMIII1	735.0	735.0	.0
MMIII2	882.0	882.0	.0
POSEID	2432.0	2432.0	.0
TRIDNT	1843.2	1843.2	.0
B52GRV	227.8	227.8	.0
B52SRM	533.8	533.8	.0
52HGRV	306.0	306.0	.0
52ALCM	856.8	856.8	.0
111SRM	204.0	204.0	.0
FB111	102.0	102.0	.0

1985 LEADERSHIP TARGETING : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 1845.3.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	POSEID	312.39	.70	.70	42.0
LOCAL	POSEID	164.78	.70	.70	64.5
C3I	TITAN	33.30	.70	.70	135.0
	TRIDNT	1387.21			
	B52GRV	88.44			
	B52SRM	207.24			
	52HGRV	118.80			
	111SRM	79.20			
ICBM	MMII	405.00	.60	.40	599.7
	MMIII2	800.24			
	52ALCM	332.64			
LCC	MMIII1	599.15	.60	.60	80.0
	MMIII2	9.76			
	POSEID	368.98			
NUKSTO	MMIII1	75.85	.60	.60	20.0
	FB111	39.60			
SUBPTS	POSEID	27.41	.60	.60	8.0
IRBM	POSEID	85.44	.60	.60	60.0
AFBASE	POSEID	14.23	.50	.20	80.0
STORES	POSEID	181.72	.50	.20	344.0
	TRIDNT	133.43			
FACIL	POSEID	172.42	.50	.20	416.0
FACTOR	POSEID	85.49	.40	.10	990.0
DEPOS	POSEID	109.05	.50	.20	440.0
NAVAL	POSEID	26.01	.50	.20	104.0
POL	POSEID	85.11	.40	.10	1170.0
ENERGY	POSEID	38.96	.40	.10	391.5

WPNAME	NUMBER	USED	REMAIN
TITAN	33.3	33.3	.0
MMII	405.0	405.0	.0
MMIII1	675.0	675.0	.0
MMIII2	810.0	810.0	.0
POSEID	1672.0	1672.0	.0
TRIDNT	1520.6	1520.6	.0
B52GRV	88.4	88.4	.0
B52SRM	207.2	207.2	.0
52HGRV	118.8	118.8	.0
52ALCM	332.6	332.6	.0
111SRM	79.2	79.2	.0
FB111	39.6	39.6	.0

1985 COUNTERVALUE TARGETING : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4579.5.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	B52SRM	29.81	.70	.70	42.0
	111SRM	204.00			
LOCAL	POSEID	164.78	.70	.70	64.5
C3I	MMII	438.31	.70	.70	135.0
	MMIII1	407.61			
	FB111	102.00			
ICBM	MMII	2.69	.50	.50	500.0
	MMIII2	517.68			
	52ALCM	856.80			
LCC	MMIII2	298.32	.50	.50	100.0
NUKSTO	MMIII2	66.00	.50	.50	25.0
SUBPTS	B52SRM	16.66	.50	.50	10.0
IRBM	POSEID	64.64	.50	.50	75.0
AFBASE	POSEID	58.44	.60	.60	40.0
STORES	MMIII1	271.71	.60	.60	172.0
	B52SRM	436.24			
FACIL	TRIDNT	475.57	.60	.60	208.0
	B52SRM	51.09			
FACTOR	POSEID	844.07	.80	.80	220.0
	TRIDNT	414.32			
DEPOS	TRIDNT	373.13	.60	.60	220.0
NAVAL	TRIDNT	86.76	.60	.60	52.0
POL	POSEID	1300.07	.80	.80	260.0
ENERGY	TRIDNT	493.42	.80	.80	87.0

WPNAME	NUMBER	USED	REMAIN
TITAN	36.3	.0	36.3
MMII	441.0	441.0	.0
MMIII1	735.0	679.3	55.7
MMIII2	882.0	882.0	.0
POSEID	2432.0	2432.0	.0
TRIDNT	1843.2	1843.2	.0
B52GRV	227.8	.0	227.8
B52SRM	533.8	533.8	.0
52HGRV	306.0	.0	306.0
52ALCM	856.8	856.8	.0
111SRM	204.0	204.0	.0
FB111	102.0	102.0	.0

1985 COUNTERFORCE TARGETING : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 2050.6.

TGTNAM	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	POSEID	57.90	.50	.20	112.0
LOCAL	POSEID	30.54	.50	.20	172.0
C31	TITAN	33.30	.70	.70	135.0
	TRIDNT	1387.21			
	B52GRV	88.44			
	B52SRM	207.24			
	52HGRV	118.80			
	111SRM	79.20			
ICBM	MMII	405.00	.70	.40	600.0
	MMIII2	797.99			
	52ALCM	332.64			
LCC	MMIII1	550.42	.70	.54	91.9
	MMIII2	12.01			
	POSEID	159.81			
NUKSTO	MMIII1	124.58	.70	.70	15.0
	FB111	39.60			
SUBPTS	POSEID	36.02	.70	.70	6.0
IRBM	POSEID	33.26	.60	.30	105.0
AFBASE	POSEID	22.75	.60	.30	70.0
STORES	POSEID	427.68	.60	.30	301.0
	TRIDNT	133.43			
FACIL	POSEID	275.59	.60	.30	364.0
FACTOR	POSEID	85.49	.40	.10	990.0
DEPOS	POSEID	174.30	.60	.30	385.0
NAVAL	POSEID	41.58	.60	.30	91.0
POL	POSEID	288.11	.40	.30	910.0
ENERGY	POSEID	38.96	.40	.10	391.5

WPNAME	NUMBER	USED	REMAIN
TITAN	33.3	33.3	.0
MMII	405.0	405.0	.0
MMIII1	675.0	675.0	.0
MMIII2	810.0	810.0	.0
POSEID	1672.0	1672.0	.0
TRIDNT	1520.6	1520.6	.0
B52GRV	88.4	88.4	.0
B52SRM	207.2	207.2	.0
52HGRV	118.8	118.8	.0
52ALCM	332.6	332.6	.0
111SRM	79.2	79.2	.0
FB111	39.6	39.6	.0

1985 COUNTERVALUE TARGETING : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3809.0.

TGTNAM	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	B52GRV	88.44	.60	.60	56.0
	52HGRV	118.80			
	111SRM	20.41			
LOCAL	POSEID	125.41	.60	.60	86.0
C3I	TITAN	33.30	.60	.60	180.0
	MMII	333.05			
	MMIII1	351.97			
	FB111	39.60			
ICBM	MMII	71.95	.40	.31	691.5
	MMIII2	541.51			
	52ALCM	332.64			
LCC	MMIII2	219.85	.40	.40	120.0
NUKSTO	MMIII2	48.64	.40	.40	30.0
SUBPTS	111SRM	12.28	.40	.40	12.0
IRBM	POSEID	47.63	.40	.40	90.0
AFBASE	POSEID	44.21	.50	.50	50.0
STORES	MMIII1	323.03	.50	.50	215.0
	B52SRM	168.70			
	111SRM	46.51			
FACIL	TRIDNT	359.84	.50	.50	260.0
	B52SRM	38.54			
FACTOR	POSEID	482.20	.70	.70	330.0
	TRIDNT	443.79			
DEPOS	TRIDNT	282.26	.50	.50	275.0
NAVAL	TRIDNT	65.63	.50	.50	65.0
POL	POSEID	972.54	.70	.70	390.0
ENERGY	TRIDNT	369.11	.70	.70	130.5

WPNAME	NUMBER	USED	REMAIN
TITAN	33.3	33.3	.0
MMII	405.0	405.0	.0
MMIII1	675.0	675.0	.0
MMIII2	810.0	810.0	.0
POSEID	1672.0	1672.0	.0
TRIDNT	1520.6	1520.6	.0
B52GRV	88.4	88.4	.0
B52SRM	207.2	207.2	.0
52HGRV	118.8	118.8	.0
52ALCM	332.6	332.6	.0
111SRM	79.2	79.2	.0
FB111	39.6	39.6	.0

1985 SOVIET ATTACK

TOTAL VALUE DESTROYED WAS 740.5

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
ICBM	SS19	2074.00	.70	.65	363.1
SACBAS	TYFOON	83.06	.90	.90	5.0
SUBPTS	SS19	16.63	.90	.90	1.0
LDRSHP	SS17	13.29	.90	.90	.8
C31	SS19	11.84	.90	.90	.6

WPNAME	NUMBER	USED	REMAIN
SS11	362.6	.0	362.6
SS11M3	441.0	.0	441.0
SS13	58.8	.0	58.8
SS17	588.0	13.3	574.7
SS18	2414.7	.0	2414.7
SS19	2116.8	2102.5	14.3
YANKEE	276.0	.0	276.0
DELTA	231.0	.0	231.0
DELTA3	672.0	.0	672.0
TYFOON	270.0	83.1	186.9
BEAR	320.0	.0	320.0
BISON	137.6	.0	137.6
BFIRE	320.0	.0	320.0

1990 LEADERSHIP TARGETING : START AND KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4023.5.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	BIBGRV	188.57	.80	.80	28.0
LOCAL	TRIDC4	215.42	.80	.80	43.0
C3I	52ALCM	790.68	.80	.80	90.0
ICBM	MX12A	869.55	.70	.70	150.0
LCC	52ALCM	271.56	.70	.70	60.0
NUKSTO	52ALCM	66.65	.70	.70	15.0
SUBPTS	TRIDC4	25.44	.70	.70	6.0
IRBM	TRIDC4	299.23	.70	.70	120.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	52ALCM	230.63	.60	.60	208.0
	BIBMC	65.30			
	TRIDD5	99.20			
FACTOR	TRIDC4	504.51	.50	.50	550.0
DEPOS	TRIDC4	373.13	.60	.60	220.0
NAVAL	TRIDC4	86.76	.60	.60	52.0
POL	TRIDC4	559.88	.50	.50	650.0
ENERGY	TRIDC4	212.50	.50	.50	217.5
MICBM	BIBGRV	151.43	.70	.70	45.0
	BIBMC	614.70			

WPNAME	NUMBER	USED	REMAIN
MMII	441.0	.0	441.0
MMIII1	735.0	.0	735.0
MMIII2	882.0	.0	882.0
POSEID	2432.0	.0	2432.0
TRIDC4	3072.0	2334.0	738.0
B52GRV	159.8	.0	159.8
B52SRM	465.8	.0	465.8
52HGRV	306.0	.0	306.0
52ALCM	1601.4	1359.5	241.9
111SRM	204.0	.0	204.0
FB111	102.0	.0	102.0
BIBGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	869.6	110.4
TRIDD5	307.2	307.2	.0

1990 COUNTERFORCE TARGETING : START : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4287.3.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	52ALCM	41.63	.60	.60	56.0
	FB111	102.00			
LOCAL	TRIDC4	122.64	.60	.60	86.0
C3I	52ALCM	790.68	.80	.80	90.0
ICBM	52ALCM	190.95	.80	.80	100.0
	MX12A	980.00			
LCC	52ALCM	363.01	.80	.80	40.0
NUKSTO	52ALCM	89.09	.80	.80	10.0
SUBPTS	TRIDC4	34.00	.80	.80	4.0
IRBM	TRIDC4	374.04	.70	.70	150.0
AFBASE	TRIDC4	75.05	.70	.70	30.0
STORES	TRIDD5	273.30	.70	.70	129.0
FACIL	TRIDC4	487.82	.70	.70	156.0
	52ALCM	126.03			
	TRIDD5	33.90			
FACTOR	TRIDC4	504.51	.50	.50	550.0
DEPOS	TRIDC4	490.28	.70	.70	165.0
NAVAL	TRIDC4	114.00	.70	.70	39.0
POL	TRIDC4	559.88	.50	.50	650.0
ENERGY	TRIDC4	212.50	.50	.50	217.5
MICBM	BIBGRV	340.00	.80	.80	30.2
	BIBMC	680.00			

WPNAME	NUMBER	USED	REMAIN
MMII	441.0	.0	441.0
MMIII1	735.0	.0	735.0
MMIII2	882.0	.0	882.0
POSEID	2432.0	.0	2432.0
TRIDC4	3072.0	2974.7	97.3
B52GRV	159.8	.0	159.8
B52SRM	465.8	.0	465.8
52HGRV	306.0	.0	306.0
52ALCM	1601.4	1601.4	.0
111SRM	204.0	.0	204.0
FB111	102.0	102.0	.0
BIBGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	980.0	.0
TRIDD5	307.2	307.2	.0

1990 COUNTERFORCE : KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 3933.8.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	52ALCM	41.63	.60	.60	56.0
	FB111	102.00			
LOCAL	TRIDC4	122.64	.60	.60	86.0
C3I	52ALCM	790.68	.80	.80	90.0
ICBM	52ALCM	49.96	.80	.80	100.0
	MX12A	980.00			
LCC	52ALCM	363.01	.80	.80	40.0
NUKSTO	52ALCM	89.09	.80	.80	10.0
SUBPTS	TRIDC4	34.00	.80	.80	4.0
IRBM	TRIDC4	299.23	.70	.70	120.0
AFBASE	TRIDC4	75.05	.70	.70	30.0
STORES	TRIDD5	273.30	.70	.70	129.0
FACIL	TRIDC4	346.82	.70	.70	156.0
	52ALCM	267.02			
	TRIDD5	33.90			
FACTOR	TRIDC4	371.81	.50	.40	660.0
DEPOS	TRIDC4	490.28	.70	.70	165.0
NAVAL	TRIDC4	114.00	.70	.70	39.0
POL	TRIDC4	508.61	.50	.46	703.8
ENERGY	TRIDC4	156.61	.40	.40	261.0
MICBM	B1BGRV	340.00	.80	.80	30.2
	BIBMC	680.00			

WPNAME	NUMBER	USED	REMAIN
MMII	441.0	.0	441.0
MMIII1	735.0	.0	735.0
MMIII2	882.0	.0	882.0
POSEID	2432.0	.0	2432.0
TRIDC4	3072.0	2519.1	552.9
B52GRV	227.8	.0	227.8
B52SRM	533.8	.0	533.8
52HGRV	306.0	.0	306.0
52ALCM	1601.4	1601.4	.0
111SRM	204.0	.0	204.0
FB111	102.0	102.0	.0
B1BGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	980.0	.0
TRIDD5	307.2	307.2	.0

1990 COUNTERVALUE TARGETING : START 2 KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4579.5.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	BIBGRV	141.06	.70	.70	42.0
LOCAL	TRIDC4	161.15	.70	.70	64.5
C3I	52ALCM	332.61	.70	.70	135.0
	BIBMC	197.03			
ICBM	MX12A	500.62	.50	.50	250.0
LCC	52ALCM	156.34	.50	.50	100.0
NUKSTO	52ALCM	38.37	.50	.50	25.0
SUBPTS	TRIDC4	14.64	.50	.50	10.0
IRBM	TRIDC4	215.34	.50	.50	250.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	BIBMC	240.83	.60	.60	208.0
	TRIDD5	99.20			
FACTOR	TRIDC4	1171.44	.80	.80	220.0
DEPOS	TRIDC4	373.13	.60	.60	220.0
NAVAL	TRIDC4	86.76	.60	.60	52.0
POL	POSEID	801.04	.80	.80	260.0
	TRIDC4	499.00			
ENERGY	TRIDC4	493.42	.80	.80	87.0
MICBM	BIBGRV	198.94	.50	.50	75.0
	BIBMC	242.14			

WPNAME	NUMBER	USED	REMAIN
MMII	441.0	.0	441.0
MMIII1	735.0	.0	735.0
MMIII2	882.0	.0	882.0
POSEID	2432.0	801.0	1631.0
TRIDC4	3072.0	3072.0	.0
B52GRV	159.8	.0	159.8
B52SRM	465.8	.0	465.8
52HGRV	306.0	.0	306.0
52ALCM	1601.4	527.3	1074.1
111SRM	204.0	.0	204.0
FB111	102.0	.0	102.0
BIBGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	500.6	479.4
TRIDD5	307.2	307.2	.0

1990 LEADERSHIP : START & KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3012.5.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDC4	102.64	.70	.70	42.0
	52ALCM	83.62			
	MX12A	17.57			
LOCAL	TRIDC4	161.15	.70	.70	64.5
C3I	52ALCM	396.30	.70	.70	135.0
	TRIDD5	96.10			
ICBM	MX12A	581.82	.60	.60	200.0
LCC	MX12A	201.61	.60	.60	80.0
NUKSTO	52ALCM	50.72	.60	.60	20.0
SUBPTS	TRIDC4	19.36	.60	.60	8.0
IRBM	TRIDC4	227.73	.60	.60	160.0
AFBASE	TRIDC4	43.21	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	TRIDC4	393.49	.50	.50	260.0
FACTOR	TRIDC4	186.82	.40	.23	851.0
DEPOS	TRIDC4	282.26	.50	.50	275.0
NAVAL	TRIDC4	65.63	.50	.50	65.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDC4	32.30	.40	.10	391.5
MICBM	B1BGRV	132.00	.60	.46	80.5
	BIBMC	264.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	1927.2	1927.2	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	530.6	530.6	.0
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	801.0	801.0	.0
TRIDD5	253.4	253.4	.0

1990 COUNTERFORCE : START : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3370.4.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDC4	88.45	.50	.50	70.0
	FB111	39.60			
LOCAL	TRIDC4	92.78	.50	.50	107.5
C3I	52ALCM	422.42	.70	.70	135.0
	TRIDD5	83.24			
ICBM	MX12A	764.49	.70	.70	150.0
LCC	52ALCM	132.65	.70	.70	60.0
	MX12A	135.51			
NUKSTO	52ALCM	66.65	.70	.70	15.0
SUBPTS	TRIDC4	25.44	.70	.70	6.0
IRBM	TRIDC4	227.73	.60	.60	160.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDC4	178.44	.60	.60	172.0
	TRIDD5	170.20			
FACIL	TRIDC4	520.16	.60	.60	208.0
FACTOR	TRIDC4	360.28	.40	.39	672.4
DEPOS	TRIDC4	373.13	.60	.60	220.0
NAVAL	TRIDC4	86.76	.60	.60	52.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDC4	32.30	.40	.10	391.5
MICBM	B1BGRV	132.00	.70	.46	80.5
	BIBMC	264.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2455.2	2455.2	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	621.7	621.7	.0
111SRM	.0	.0	.0
FB111	39.6	39.6	.0
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	900.0	900.0	.0
TRIDD5	253.4	253.4	.0

1990 COUNTERFORCE : KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 2992.6.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDC4	127.45	.50	.50	70.0
LOCAL	TRIDC4	92.78	.50	.50	107.5
C3I	52ALCM	422.42	.70	.70	135.0
	TRIDD5	83.24			
ICBM	MX12A	764.49	.70	.70	150.0
LCC	52ALCM	132.65	.70	.70	60.0
	MX12A	135.51			
NUKSTO	52ALCM	66.65	.70	.70	15.0
SUBPTS	TRIDC4	25.44	.70	.70	6.0
IRBM	TRIDC4	227.73	.60	.60	160.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDC4	92.12	.60	.60	172.0
	FB111	39.60			
	TRIDD5	170.20			
FACIL	TRIDC4	520.76	.60	.60	208.0
FACTOR	TRIDC4	76.67	.40	.10	990.0
DEPOS	TRIDC4	373.13	.60	.60	220.0
NAVAL	TRIDC4	86.76	.60	.60	52.0
POL	TRIDC4	352.81	.40	.35	839.9
ENERGY	TRIDC4	32.30	.40	.10	391.5
MICBM	B1BGRV	132.00	.70	.46	80.9
	BIBMC	264.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2064.5	2064.5	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	621.7	621.7	.0
111SRM	.0	.0	.0
FB111	39.6	39.6	.0
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	900.0	900.0	.0
TRIDD5	253.4	253.4	.0

1990 COUNTERVALUE : START & KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3858.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	B1BGRV	107.35	.60	.60	56.0
LOCAL	TRIDC4	122.64	.60	.60	86.0
C3I	52ALCM	181.94	.60	.60	180.0
	BIBMC	204.14			
ICBM	MX12A	324.36	.40	.40	300.0
LCC	MX12A	112.40	.40	.40	120.0
NUKSTO	52ALCM	23.98	.40	.40	30.0
	MX12A	4.24			
SUBPTS	TRIDC4	10.79	.40	.40	12.0
IREM	TRIDC4	158.70	.40	.40	300.0
AFBASE	TRIDC4	43.21	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	TRIDC4	188.71	.50	.50	260.0
	BIBMC	5.66			
	TRIDD5	96.10			
FACTOR	TRIDC4	876.32	.70	.70	330.0
DEPOS	TRIDC4	282.26	.50	.50	275.0
NAVAL	TRIDC4	65.63	.50	.50	65.0
POL	POSEID	555.50	.70	.70	390.0
	TRIDC4	417.02			
ENERGY	TRIDC4	369.11	.70	.70	130.5
MICBM	B1BGRV	24.65	.40	.12	132.5
	BIBMC	54.20			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	555.5	555.5	.0
TRIDC4	2534.4	2534.4	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	205.9	205.9	.0
11 SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	441.0	441.0	.0
TRIDD5	253.4	253.4	.0

1990 SOVIET STRIKE

TOTAL VALUE DESTROYED WAS 156.3.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
ICBM	SS24	200.00	.90	.90	10.3
SACBAS	TYFOON	83.06	.90	.90	5.0
SUBPTS	SS24	14.31	.90	.90	1.0
LDRSHP	SS24	11.45	.90	.90	.8
C3I	SS24	8.70	.90	.90	.6

WPNAME	NUMBER	USED	REMAIN
SS17	392.0	.0	392.0
SS18	1176.0	.0	1176.0
SS19	588.0	.0	588.0
SS24	1470.0	234.5	1235.5
SS25	147.0	.0	147.0
DELTA	42.0	.0	42.0
DELTA3	720.0	.0	720.0
TYFOON	1080.0	83.1	996.9
BEARCM	160.0	.0	160.0
BFIRE	400.0	.0	400.0
BLKJAK	480.0	.0	480.0

1995 LEADERSHIP : KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4125.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	25.03	.80	.80	28.0
	SICBM	154.75			
LOCAL	TRIDD5	182.40	.80	.80	43.0
C3I	TRIDD5	389.27	.80	.80	90.0
ICBM	SICBM	221.33	.70	.70	58.5
LCC	SICBM	200.86	.70	.70	60.0
NUKSTO	TRIDD5	36.23	.70	.70	15.0
SUBPTS	TRIDD5	12.73	.70	.70	6.0
IRBM	TRIDC4	250.21	.70	.70	150.0
	TRIDD5	105.05			
AFBASE	TRIDD5	48.30	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDD5	401.91	.50	.50	550.0
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	559.88	.50	.50	650.0
ENERGY	TRIDD5	158.94	.50	.50	217.5
MICBM	BIBMC	624.57	.70	.70	150.0
	ATB	1275.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2336.0	810.1	1525.9
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	1366.8	.0	1366.8
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	340.0	.0	340.0
BIBMC	680.0	624.6	55.4
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	576.9	109.1
ATB	1275.0	1275.0	.0

1995 LEADERSHIP : START : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4125.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	138.67	.80	.80	28.0
LOCAL	TRIDC4	192.32	.80	.80	43.0
	TRIDD5	19.55			
C3I	TRIDD5	389.27	.80	.80	90.0
ICBM	SICBM	221.33	.70	.70	58.5
LCC	TRIDD5	154.26	.70	.70	60.0
NUKSTO	TRIDD5	36.23	.70	.70	15.0
SUBPTS	TRIDD5	12.73	.70	.70	6.0
IRBM	TRIDC4	374.04	.70	.70	150.0
AFBASE	TRIDD5	48.30	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDD5	401.91	.50	.50	550.0
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	559.88	.50	.50	650.0
ENERGY	TRIDD5	158.94	.50	.50	217.5
MICBM	BIBMC	624.57	.70	.70	150.0
	ATB	1275.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2336.0	1126.2	1209.8
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	1366.8	.0	1366.8
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	340.0	.0	340.0
BIBMC	680.0	624.6	55.4
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	221.3	464.7
ATB	1275.0	1275.0	.0

1995 COUNTERFORCE : KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 3359.5.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	FB111	102.00	.60	.60	56.0
	SICBM	31.06			
LOCAL	TRIDD5	103.84	.60	.60	86.0
C3I	TRIDD5	389.27	.80	.80	90.0
ICBM	SICBM	295.86	.80	.80	39.0
LCC	SICBM	268.51	.80	.80	40.0
NUKSTO	SICBM	66.89	.80	.80	10.0
SUBPTS	TRIDD5	17.01	.80	.80	4.0
IRBM	TRIDD5	317.32	.70	.70	150.0
AFBASE	TRIDD5	63.46	.70	.70	30.0
STORES	TRIDD5	273.30	.70	.70	129.0
FACIL	TRIDD5	332.82	.70	.70	156.0
FACTOR	TRIDD5	61.09	.40	.10	990.0
DEPOS	TRIDD5	350.13	.70	.70	165.0
NAVAL	TRIDD5	82.50	.70	.70	39.0
POL	TRIDC4	72.24	.40	.25	975.5
	TRIDD5	135.49			
ENERGY	TRIDD5	24.16	.40	.10	391.5
MICBM	B1BGRV	340.00	.80	.75	124.5
	BIBMC	680.00			
	ATB	1275.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2502.4	72.2	2430.2
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	1601.4	.0	1601.4
111SRM	.0	.0	.0
FB111	102.0	102.0	.0
B1BGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	662.3	23.7
ATB	1275.0	1275.0	.0

1995 COUNTERFORCE : START : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4299.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	78.95	.60	.60	56.0
LOCAL	TRIDC4	122.64	.60	.60	86.0
C3I	TRIDD5	389.27	.80	.80	90.0
ICBM	SICBM	295.86	.80	.80	39.0
LCC	52ALCM	232.49	.80	.80	40.0
	TRIDD5	17.14			
	SICBM	74.22			
NUKSTO	TRIDD5	48.43	.80	.80	10.0
SUBPTS	TRIDD5	17.01	.80	.80	4.0
IRBM	TRIDC4	374.04	.70	.70	150.0
AFBASE	TRIDC4	75.05	.70	.70	30.0
STORES	TRIDD5	273.30	.70	.70	129.0
FACIL	TRIDD5	332.82	.70	.70	156.0
FACTOR	TRIDD5	401.91	.50	.50	550.0
DEPOS	TRIDD5	350.13	.70	.70	165.0
NAVAL	TRIDD5	82.50	.70	.70	39.0
POL	TRIDC4	559.88	.50	.50	650.0
ENERGY	TRIDD5	158.94	.50	.50	217.5
MICBM	B1BGRV	340.00	.80	.75	124.5
	BIBMC	680.00			
	ATB	1275.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	2976.0	1131.6	1844.4
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	1601.4	232.5	1368.9
111SRM	.0	.0	.0
FB111	102.0	.0	102.0
B1BGRV	340.0	340.0	.0
BIBMC	680.0	680.0	.0
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	370.1	315.9
ATB	1275.0	1275.0	.0

1995 COUNTERVALUE : KENT : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4602.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	19.14	.70	.70	42.0
	ATB	99.44			
LOCAL	TRIDC4	161.15	.70	.70	64.5
C3I	TRIDD5	291.20	.70	.70	135.0
ICBM	ATB	103.79	.50	.50	97.5
LCC	ATB	100.09	.50	.50	100.0
NUKSTO	TRIDD5	20.86	.50	.50	25.0
SUBPTS	TRIDD5	7.33	.50	.50	10.0
IRBM	TRIDC4	215.34	.50	.50	250.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDC4	352.63	.80	.80	220.0
	TRIDD5	652.29			
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	1300.00	.80	.80	260.0
ENERGY	TRIDD5	369.04	.80	.80	87.0
MICBM	ATB	971.68	.50	.50	250.0

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	808.0	.0	808.0
TRIDC4	3072.0	2086.2	985.8
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	530.4	.0	530.4
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	340.0	.0	340.0
BIBMC	680.0	.0	680.0
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	.0	686.0
ATB	1275.0	1275.0	.0

1995 COUNTERVALUE : START : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4602.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	ATB	121.93	.70	.70	42.0
LOCAL	TRIDC4	161.15	.70	.70	64.5
C3I	TRIDD5	291.20	.70	.70	135.0
ICBM	SICBM	51.63	.50	.50	97.5
	ATB	61.74			
LCC	SICBM	115.64	.50	.50	100.0
NUKSTO	SICBM	28.81	.50	.50	25.0
SUBPTS	TRIDD5	7.33	.50	.50	10.0
IRBM	TRIDC4	215.34	.50	.50	250.0
AFBASE	TRIDC4	57.12	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDC4	302.42	.80	.80	220.0
	TRIDD5	692.28			
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	1300.00	.80	.80	260.0
ENERGY	TRIDD5	369.04	.80	.80	87.0
MICBM	ATB	971.68	.50	.50	250.0

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	808.0	.0	808.0
TRIDC4	3072.0	2036.0	1036.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	530.4	.0	530.4
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	340.0	.0	340.0
BIBMC	680.0	.0	680.0
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	196.1	489.9
ATB	1275.0	1155.3	119.7

1995 COUNTERVALUE : START : GENERATED ALERT

TOTAL VALUE DESTROYED WAS 4602.0.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	ATB	121.93	.70	.70	42.0
LOCAL	TRIDD5	136.45	.70	.70	64.5
C3I	BIBMC	308.84	.70	.70	135.0
	SICBM	141.28			
ICBM	ATB	103.79	.50	.50	97.5
LCC	SICBM	25.99	.50	.50	100.0
	ATB	77.60			
NUKSTO	SICBM	28.81	.50	.50	25.0
SUBPTS	TRIDD5	7.33	.50	.50	10.0
IRBM	TRIDD5	182.68	.50	.50	250.0
AFBASE	TRIDD5	48.30	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	B1BGRV	24.71	.60	.60	208.0
	BIBMC	371.16			
FACTOR	TRIDD5	933.20	.80	.80	220.0
DEPOS	B1BGRV	135.48	.60	.60	220.0
	TRIDD5	180.22			
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	1273.60	.80	.80	260.0
	TRIDD5	22.40			
ENERGY	TRIDD5	369.04	.80	.80	87.0
MICBM	ATB	971.68	.50	.50	250.0

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	808.0	.0	808.0
TRIDC4	3072.0	1273.6	1798.4
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	530.4	.0	530.4
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	340.0	160.2	179.8
BIBMC	680.0	680.0	.0
MX12A	980.0	.0	980.0
TRIDD5	2150.4	2150.4	.0
SICBM	686.0	196.1	489.9
ATB	1275.0	1275.0	.0

1995 LEADERSHIP : KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3328.3.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	103.74	.70	.70	42.0
LOCAL	TRIDD5	136.45	.70	.70	64.5
C3I	TRIDD5	291.20	.70	.70	135.0
ICBM	SICBM	168.44	.60	.60	78.0
LCC	TRIDD5	117.40	.60	.60	80.0
NUKSTO	TRIDD5	27.57	.60	.60	20.0
SUBPTS	TRIDD5	9.68	.60	.60	8.0
IRBM	TRIDC4	237.33	.60	.60	200.0
	TRIDD5	40.15			
AFBASE	TRIDD5	36.54	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	TRIDD5	191.61	.50	.50	260.0
FACTOR	TRIDD5	296.19	.40	.40	660.0
DEPOS	TRIDD5	201.58	.50	.50	275.0
NAVAL	TRIDD5	47.50	.50	.50	65.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDD5	117.13	.40	.40	261.0
MICBM	BIBMC	242.88	.60	.37	313.2
	ATB	495.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	670.6	649.9	20.6
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	.0	.0	.0
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	.0	.0	.0
BIBMC	242.9	242.9	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	530.1	168.4	361.7
ATB	495.0	495.0	.0

1995 LEADERSHIP : START : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3328.3.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	103.74	.70	.70	42.0
LOCAL	TRIDD5	136.45	.70	.70	64.5
C3I	TRIDD5	291.20	.70	.70	135.0
ICBM	SICBM	168.44	.60	.60	78.0
LCC	TRIDD5	117.40	.60	.60	80.0
NUKSTO	TRIDD5	27.57	.60	.60	20.0
SUBPTS	TRIDD5	9.68	.60	.60	8.0
IRBM	TRIDC4	237.33	.60	.60	200.0
	TRIDD5	40.15			
AFBASE	TRIDD5	36.54	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	TRIDD5	191.61	.50	.50	260.0
FACTOR	TRIDD5	296.19	.40	.40	660.0
DEPOS	TRIDD5	201.58	.50	.50	275.0
NAVAL	TRIDD5	47.50	.50	.50	65.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDD5	117.13	.40	.40	261.0
MICBM	BIBMC	242.88	.60	.37	313.2
	ATB	495.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	929.3	649.9	279.3
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	.0	.0	.0
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	.0	.0	.0
BIBMC	242.9	242.9	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	203.4	168.4	35.0
ATB	495.0	495.0	.0

1995 COUNTERFORCE : KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3498.6.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	SICBM	81.33	.50	.50	70.0
LOCAL	TRIDD5	78.55	.50	.50	107.5
C3I	TRIDD5	264.62	.70	.70	135.0
	SICBM	41.07			
ICBM	SICBM	221.33	.70	.70	58.5
LCC	SICBM	200.86	.70	.70	60.0
NUKSTO	SICBM	50.04	.70	.70	15.0
SUBPTS	TRIDD5	12.73	.70	.70	6.0
IRBM	TRIDC4	88.99	.60	.60	200.0
	TRIDD5	166.00			
AFBASE	TRIDD5	48.30	.60	.60	40.0
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDD5	296.19	.40	.40	660.0
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDD5	117.13	.40	.40	261.0
MICBM	B1BGRV	132.00	.70	.42	291.4
	BIBMC	264.00			
	ATB	495.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	501.6	501.6	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	.0	.0	.0
111SRM	.0	.0	.0
FB111	39.6	.0	39.6
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	608.4	594.6	13.8
ATB	495.0	495.0	.0

1995 COUNTERFORCE : START : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3498.6.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	59.72	.50	.50	70.0
LOCAL	TRIDC4	92.78	.50	.50	107.5
C3I	TRIDD5	291.20	.70	.70	135.0
ICBM	SICBM	221.33	.70	.70	58.5
LCC	TRIDD5	154.26	.70	.70	60.0
NUKSTO	TRIDD5	36.23	.70	.70	15.0
SUBPTS	TRIDD5	12.73	.70	.70	6.0
IRBM	TRIDC4	284.66	.60	.60	200.0
AFBASE	TRIDC4	38.11	.60	.60	40.0
	TRIDD5	16.07			
STORES	TRIDD5	208.00	.60	.60	172.0
FACIL	TRIDD5	253.30	.60	.60	208.0
FACTOR	TRIDD5	296.19	.40	.40	660.0
DEPOS	TRIDD5	266.47	.60	.60	220.0
NAVAL	TRIDD5	62.79	.60	.60	52.0
POL	TRIDC4	412.61	.40	.40	780.0
ENERGY	TRIDD5	117.13	.40	.40	261.0
MICBM	B1BGRV	132.00	.70	.42	291.4
	BIBMC	264.00			
	ATB	495.00			

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	934.6	828.2	106.4
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	91.1	.0	91.1
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	132.0	132.0	.0
BIBMC	264.0	264.0	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	340.2	221.3	118.9
ATB	495.0	495.0	.0

1995 COUNTERVALUE : KENT : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3856.2.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	TRIDD5	78.95	.60	.60	56.0
LOCAL	TRIDC4	122.64	.60	.60	86.0
C3I	TRIDD5	221.62	.60	.60	180.0
ICBM	SICBM	93.91	.40	.40	117.0
LCC	TRIDD5	65.45	.40	.40	120.0
NUKSTO	TRIDD5	15.37	.40	.40	30.0
SUBPTS	TRIDD5	5.40	.40	.40	12.0
IRBM	TRIDC4	158.70	.40	.40	300.0
AFBASE	TRIDC4	43.21	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	TRIDD5	191.61	.50	.50	260.0
FACTOR	TRIDC4	232.11	.70	.70	330.0
	TRIDD5	513.20			
DEPOS	TRIDD5	201.58	.50	.50	275.0
NAVAL	TRIDD5	47.50	.50	.50	65.0
POL	TRIDC4	972.49	.70	.70	390.0
ENERGY	TRIDD5	276.06	.70	.70	130.5
MICBM	ATB	451.44	.40	.28	362.3

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	.0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	1684.3	1529.1	155.2
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	.0	.0	.0
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	.0	.0	.0
BIBMC	.0	.0	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	180.0	93.9	86.1
ATB	451.4	451.4	.0

1995 COUNTERVALUE : START : DAY-TO-DAY

TOTAL VALUE DESTROYED WAS 3831.7.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
CIVIL	B1BGRV	44.35	.60	.60	56.0
	ATB	54.46			
LOCAL	TRIDD5	103.84	.60	.60	86.0
C3I	BIBMC	264.00	.60	.60	180.0
	SICBM	78.58			
ICBM	ATB	76.49	.40	.40	117.0
LCC	SICBM	80.19	.40	.40	120.0
	ATB	4.36			
NUKSTO	SICBM	21.23	.40	.40	30.0
SUBPTS	TRIDD5	5.40	.40	.40	12.0
IRBM	TRIDC4	78.23	.40	.40	300.0
	TRIDD5	68.27			
AFBASE	TRIDD5	36.54	.50	.50	50.0
STORES	TRIDD5	157.34	.50	.50	215.0
FACIL	B1BGRV	19.01	.50	.50	260.0
	TRIDD5	179.45			
FACTOR	TRIDD5	698.10	.70	.70	330.0
DEPOS	TRIDD5	201.58	.50	.50	275.0
NAVAL	TRIDD5	47.50	.50	.50	65.0
POL	TRIDC4	972.49	.70	.70	390.0
ENERGY	TRIDD5	276.06	.70	.70	130.5
MICBM	ATB	359.69	.40	.23	386.8

WPNAME	NUMBER	USED	REMAIN
MMII	.0	.0	.0
MMIII1	.0	0	.0
MMIII2	.0	.0	.0
POSEID	.0	.0	.0
TRIDC4	1050.7	1050.7	.0
B52GRV	.0	.0	.0
B52SRM	.0	.0	.0
52HGRV	.0	.0	.0
52ALCM	.0	.0	.0
111SRM	.0	.0	.0
FB111	.0	.0	.0
B1BGRV	63.4	63.4	.0
BIBMC	264.0	264.0	.0
MX12A	.0	.0	.0
TRIDD5	1774.1	1774.1	.0
SICBM	180.0	180.0	.0
ATB	495.0	495.0	.0

1995 SOVIET ATTACK : 700 MICBM TARGETS

TOTAL VALUE DESTROYED WAS 126.8.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
SACBAS	TYFOON	83.06	.90	.90	5.0
SUBPTS	SS24	14.31	.90	.90	1.0
LDRSHP	SS25	11.45	.90	.90	.8
C3I	SS24	8.70	.90	.90	.6
MICBM	SS18	352.80	.90	.09	639.8
	SS19	176.40			
	SS24	1447.00			
	SS25	478.55			
	DELTA3	336.00			
	TYFOON	1266.94			

WPNAME	NUMBER	USED	REMAIN
SS17	.0	.0	.0
SS18	352.8	352.8	.0
SS19	176.4	176.4	.0
SS24	1470.0	1470.0	.0
SS25	490.0	490.0	.0
DELTA	.0	.0	.0
DELTA3	336.0	336.0	.0
TYFOON	1350.0	1350.0	.0
BEARCM	160.0	.0	160.0
BFIRE	400.0	.0	400.0
BLKJAK	1200.0	.0	1200.0

1995 SOVIET ATTACK : 200 MICBM TARGETS

TOTAL VALUE DESTROYED WAS 120.6.

TGTNAME	WEAPON	NUMBER ASSIGNED	GOAL	ACHIEVEMENT	NUMBER REMAINING
SACBAS	TYFOON	83.06	.90	.90	5.0
SUBPTS	SS24	14.31	.90	.90	1.0
LDRSHP	SS25	11.45	.90	.90	.8
C3I	SS24	8.70	.90	.90	.6
MICBM	SS18	352.80	.90	.27	146.0
	SS19	176.40			
	SS24	1447.00			
	SS25	478.55			
	DELTA3	336.00			
	TYFOON	1266.94			

WPNAME	NUMBER	USED	REMAIN
SS17	.0	.0	.0
SS18	352.8	352.8	.0
SS19	176.4	176.4	.0
SS24	1470.0	1470.0	.0
SS25	490.0	490.0	.0
DELTA	.0	.0	.0
DELTA3	336.0	336.0	.0
TYFOON	1350.0	1350.0	.0
BEARCM	160.0	.0	160.0
BFIRE	400.0	.0	400.0
BLKJAK	1200.0	.0	1200.0

APPENDIX C: TERMINOLOGY

Advanced Technology Bomber (ATB): The so-called "Stealth" bomber. This weapon system will rely on advanced materials, engineering and electronic countermeasures equipment to greatly reduce its probability of detection by enemy radar. (8:I-2)

Antiballistic Missile (ABM) System: A system to counter strategic ballistic missiles or their elements in flight trajectory.

Antisubmarine Warfare (ASW): Measures to detect, locate, track, and destroy submarines, currently primarily dependent upon acoustic sensors.

B-1B: A follow-on bomber to the B-52. Becoming operational in 1986, the B-1B offers increased accuracy, reliability and capability to penetrate future Soviet defenses than the B-52.

B-52: The mainstay of the U.S. strategic bomber force since the 1950s. About 250 late model G and H aircraft ... are expected to remain in the inventory until the early 1990s. Many of these [have been] equipped with cruise missiles in the early 1980s, while others will continue to carry gravity bombs and short-range attack missiles.

Ballistic Missile: Any missile which does not rely upon aerodynamic surfaces to produce lift and consequently follows a ballistic trajectory (that is, one resulting when the body is acted upon only by gravity and aerodynamic drag) when thrust is terminated.

Circular Error Probable (CEP): A measure of the delivery accuracy of a weapon system used as a factor in determining probable damage to targets. It is the radius of a circle around the target at which a missile is aimed within which the warhead has a 0.5 probability of falling.

Command, Control, Communications and Intelligence (C^3I): The complete set of hardware, people, and procedures used by the national leadership and commanders at all levels to direct and monitor the operation of military forces in the conduct of their day-to-day activities and wartime missions. (20:27)

Note: Unless otherwise noted, the reference for all entries in this appendix is (25:75-79)

Counterforce Strike: An attack aimed at an adversary's military capability, especially his strategic nuclear military capability.

Cruise Missile: A guided missile which uses aerodynamic lift to offset gravity and propulsion to counteract drag. The major portion of a cruise missile's flight path remains within the atmosphere. Air launched cruise missiles are abbreviated ALCM's.

Cruise missile carrier (CMC): An aircraft capable of delivering cruise missiles to within range of their targets. Current plans call for the use of B-52 bombers [and possibly B-1B bombers] in this role.

Day-to-Day Alert: The normal state of readiness for U.S. forces. About one-third of the bomber force would be ready for instant takeoff and one half of the submarine force would be at sea.

Depressed Trajectory: The trajectory of a ballistic missile fired at an angle to the ground significantly lower than the angle of minimum energy trajectory. A method of reducing missile flight time.

Electronic Countermeasures (ECM): Measures used by bombers or other aircraft to negate the effectiveness of enemy air defense radars, surface to air missiles, and interceptor aircraft.

Equivalent Megatons (EMT): A commonly used measure of the urban area destructive power that accounts for the fact that area destructive power does not increase proportionately with increases in yield. It is expressed by the relationship EMT = N multiplied by Y to the 2/3 power, where N is the number of weapons of yield Y.

FB-111: Medium bombers procured in small numbers in the late 1960s to supplement the B-52 force. Although capable of supersonic low-level flight, the aircraft's small range and payload limits its effectiveness.

First Strike (nuclear): The launching of an initial strategic nuclear attack before the opponent has used any strategic weapons himself.

Fratricide: The destruction of warheads entering an area where previous nuclear explosions have recently taken place, especially during a large-scale attack on a small area.

Note: Unless otherwise noted, the reference for all entries in this appendix is (25:75-79)

Generated Alert: A condition when forces are placed in a high state of readiness, with the vast majority of the bomber force on ground alert ready for rapid takeoff and the vast majority of the submarine force at sea.

Hardness: The amount of protection afforded by structural shielding against blast, heat, and radiation effects of nuclear explosions, usually measured in pounds per square inch (PSI). [VNTK figures are also used, which give a more accurate representation of hardness.]

Intercontinental Ballistic Missile (ICBM): A land-based, rocket-propelled vehicle capable of delivering a warhead to intercontinental ranges (ranges in excess of 3000 nautical miles).

Kiloton (KT): The yield of a nuclear weapon [roughly] equivalent to 1000 tons of TNT.

Launch on Warning: This phrase is now usually, but not universally, used to mean launch of missiles after one side received electrical signals from radars, infra-red satellites, or other sensors that enemy missiles are on the way, but before there have been nuclear detonations on its territory. "Launch under attack" is sometimes used interchangeably with "launch on warning" and sometimes used to designate a launch after more confirmation has been received, such as indications that detonations have occured. (18:28)

Megaton (MT): The yield of a nuclear weapon [roughly] equivalent to 1,000,000 tons of TNT.

Minuteman: The mainstay of the U.S. ICBM force since the early 1960s. At the present time, the United States maintains a force of 450 single-warhead Minuteman II missiles and 550 three-warhead Minuteman III missiles.

MK-12A: A higher-yield, more accurate warhead designed to replace the MK-12 warheads presently deployed on Minuteman III missiles. MK-12A warheads may also be deployed on MX ICBMs and Trident II SLBMs.

Multiple Independently Targetable Reentry Vehicle (MIRV): Two or more reentry vehicles carried by a single missile and capable of being independently targeted.

Note: Unless otherwise noted, the reference for all entries in this appendix is (25:75-79)

MX: A more powerful, more accurate ICBM now in the research and development stage that may supplement the Minuteman force ...

Payload: The weapon system and/or cargo capacity of any aircraft or missile system, expressed variously in pounds, in number of weapons, and in terms of missile warhead yields.

Penetration Aids: Equipment, such as decoys, carried along as part of a missile's threw-weight, specifically to assist the reentry vehicle to get through ballistic missile defenses. (20:28)

Poseidon: U.S. submarines that carry the first generation of multiple-warhead, submarine launched Poseidon missiles. Each sumbmarine can carry 16 missiles... Expected to be replaced by Trident submarines during the late 1980s and early 1990s.

Reentry Vehicle (RV): That portion of a ballistic missile designed to carry a nuclear warhead and to reenter the earth's atmosphere in the terminal portion of the missile trajectory.

Second Strike: A term usually used to refer to a retaliatory attack in response to a first strike.

Silo: Underground facilities for a hard-site ballistic missile and/or crew, designed to provide prelaunch protection against nuclear effects.

Short-Range Attack Missile (SRAM): An air-to-surface missile carried by U.S. FB-111 and B-52 bombers.

Single Integrated Operations Plan (SIOP): The plan for employment of U.S. nuclear forces in wartime. (14:89)

Small ICBM (SICBM): Also known as "Midgetman", a proposed small, single-warhead mobile ICBM designed to be deployed in hardened transporters. (15:19)

SS-18: A large Soviet surface-to-surface missile. The largest ICBM in the world, the SS-18 can carry eight to ten megaton range warheads...

Note: Unless otherwise noted, the reference for all entries in this appendix is (25:75-79)

SS-19: The newest Soviet ICBM currently deployed. The SS-19 can deliver up to 6 MIRV warheads with a CEP of around 300 meters. (14:164)

SS-24: A new Soviet ICBM under development. The SS-24 is assumed to have capabilities similar to the U.S. MX missile. (14:90)

SS-25: Another new Soviet ICBM in the development stages. It is assumed to be a mobile ICBM with capabilities similar to the proposed U.S. Small ICBM. (14:90)

SSBN: Nuclear powered ballistic missile submarine.

Standard Weapon Station (SWS): A measure of throw-weight of both bombers and missiles, relating roughly to a potential warhead. MIRV missiles would count one SWS for every 400 kilograms of throw-weight, single warhead missiles one SWS for every 500 kilograms of throw-weight, and bombers one SWS for each 50,000 pounds of takeoff gross weight for gravity weapons, and one SWS per 25,000 pounds for ALCM carriers. (15:29)

Strategically Relocatable Target (SRT): A new class of target that is mobile, or has an unknown location. Mobile ICBM's are becoming very important SRTs. (no source)

Submarine Launched Ballistic Missile (SLBM): A ballistic missile carried in and launched from a submarine.

Surface to Air Missile (SAM): A surface-launched missile employed to counter airborne threats.

Throw-Weight: Ballistic missile throw-weight is the maximum useful weight which has been flight tested on the boost stages of the missile. The useful weight includes the weight of the reentry vehicles, penetration aids, dispensing and release mechanisms, guidance devices, reentry shrouds, covers, busses, and propulsion devices (but not the final stages) that are present at the end of the boost phase.

Triad: The term used in referring to the basic structure of the U.S. strategic deterrent force. It is comprised of land-based ICBMs, the strategic bomber force, and the [Poseidon/Trident] submarine fleet.

Note: Unless otherwise noted, the reference for all entries in this appendix is (25:75-79)

Trident: U.S. submarines now under construction [and deployment] that are [replacing] the Poseidon fleet. Each submarine will be able to carry 24 Trident I [C-4] or Trident II [D-5] missiles.

Typhoon: The newest Soviet ballistic missile submarine. The Typhoon carries 20 SLBMs. (14:92)

VNTK Figure: A way of expressing target hardness using the Physical Vulnerability System, which takes into account more factors than PSI hardness. It is expressed in a two-digit number (Vulnerablity number) giving the targets hardness relative to a certain damage level, followed by a single letter, giving the target's predominant sensitivity to overpressure (P) or dynamic pressure (Q) and a K factor giving an adjustment for differing lengths of blast wave duration caused by different weapon yields. For example, 50P7 would be a very hard target, like a silo. (1:34-37)

Warheads: That part of a missile, projectile, or torpedo that contains the explosive intended to inflict damage.

Yield: The force of a nuclear expcsion expressed in terms of the number of tons of TNT that would have to be exploded to produce the same energy.

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VITA

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